The Empire Cotton Growing Review

Journal of the Empire Cotton Growing Corporation

Vol. IV. 1927

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Published by

P. S. King & Son, Ltd., 14, Great Smith St., London, S.W. 1

for the Empire Cotton Growing Corporation

Quarterly: Price 1s.

Annual Subscription, 5s. post free

Printed in Great Britain

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VOL. IV. JANUARY, 1927. NO. 1

LOW PRICES FOR COTTON

OUR fourth volume commences at a time when raw cotton is very cheap. During the past autumn there was a fall of more than 3d. from the then price of over 10d., a price already much below the average post-war figure. This means a great diminution in the return to the cultivators, for the very large crop just harvested represents less money value than its predecessor. Such a result will put to a severe test the possibilities of cotton-growing throughout the world, and the probable result will be to weed out many of the less efficient farmers, and perhaps to put an end to the cultivation altogether in some districts that by climate or by local conditions are not really well adapted to cotton-growing. The high prices of the last few years have rendered it comparatively easy to make a profit anywhere that the cotton plant can grow and fruit reasonably well.

The impression is widespread that such a vast production of cotton as has just occurred should be productive of unmitigated good to all concerned, as indeed ought to be the case were our systems of supply and distribution, with the necessary co-operation, ideally organized. It is something of a satire upon present conditions that such a gratifying result will not occur, but that much trouble and distress will be caused, though a great amount of extra wealth has been created.

The one who will principally suffer, the grower of the cotton, is the one who ought in justice to profit most. He has been unusually successful in the primary object of a cultivator, the production of the largest possible crop at the least possible cost; yet he will be severely punished for his success. The crop of cotton in North America alone, cotton which is of the "bread-and-butter" type of almost universal cultivation, is estimated to exceed by at least 3 million bales the probable world's consumption in the mills for

1927. Production in excess of the actual demand involves a fall in price that more than wipes out any extra profit that ought to accrue to the growers, and in many cases may involve them in actual financial loss. Yet the grower is in general a poor man, living from hand to mouth.

Even to the spinner and the manufacturer this sudden lowering of price is by no means an unmixed blessing. Already one reads of the Bombay mills reducing output on account of the low prices and the heavy stocks on hand. The cotton is not sold in its finished condition as soon as bought, but undergoes various treatments lasting over a period of some months, so that when it is actually placed upon the market its economic selling price may stand in no necessary relation whatever to the price of raw cotton at that particular time. Goods now being sold, for example, were made from cotton purchased at 10d. or over.

What the manufacturer desires above all things is a *stable* price for raw cotton. We should be inclined to consider the price as stable when it did not, in any one year, rise or fall more than, say, 5 to 7 per cent. above or below the average price for that year. [It might, of course, be always rising, or always falling, over longer periods of one or more years.] To put it in other words, if the year's average for American middling were (say) 8d., the price might vary between 7½d and 8½d. Greater stability than this could hardly be expected, with a crop so liable to pests and diseases.

The manufacturer enters into contracts running over many months, and it is essential to their satisfactory fulfilment, and to ease and freedom in working, that the price of cotton should not vary to any serious extent during these periods, which are being commenced upon almost every day of the year. The manufacturer may be able to obtain some protection from the futures market, but this is only a partial cover, whose value becomes steadily less the further the cotton diverges in quality from middling American.

Naturally also the manufacturer desires that the price shall be as low as is possible with the assurance of stability, for low prices stimulate demand for the goods that he has to sell, and are good for trade. But sixpenny cotton without stability of price is not so good from his point of view as sevenpenny, or even eightpenny, with stability. And it is in this fact that there lies the possibility of satisfying both the manufacturer and the grower.

Lastly, it must be remembered that the spinner and the manufacturer are equipped, at great expenditure of capital, for dealing each with a certain type of cotton, and cannot readily turn to another

type, or to another fibre, or to the manufacture of something else, whereas the grower, should he find cotton unsatisfactory, can frequently find some other product to cultivate—groundnuts, for example. Cotton is an annual crop, and the ground is free at the end of the season.

The growers of cotton, on the other hand, naturally desire to obtain the highest price possible, and perhaps regard stability, though in itself very desirable, as of less importance. Too high a price defeats itself by tempting too many into the production of cotton. The average world price must evidently be that which in an average year will bring forward just about the right amount of cotton to satisfy the demands of the spinners, the differences that arise within a period of one or two years being smoothed over by the existence of the "carry-over" stock of cotton. As the actual production of the cotton is in the hands of the growers, the price must evidently be one which is not too low to satisfy them. It must bear such a relation to the prices obtainable for other possible crops as to induce the right number of growers to cultivate the right area in cotton. A great rise will induce too many to come in, a great fall will drive the growers to try something else, for their proceedings are governed not by sentiment so much as by finance.

The present low price may give the much-needed stimulus to trade in cotton products, which has long been rather depressed, with short time for many of the workers; but it is practically certain to cause a restriction of area in the coming season, especially in regions where the growers have some other crop to which they can turn. Many different panaceas, to which we shall presently come, are under consideration at present, having in view the amelioration of the position of the grower in regard to the present bumper crop. The spinner and the manufacturer must be prepared to realize that the present very low price is hardly likely to continue. They should take the long view, and should aim at greater stability of prices, with the least rise in general price that will allow of the cultivation of sufficient cotton to meet their demand. They must also remember that though Empire cultivation is rapidly increasing, it will be a long time yet before we can do without the American supply, and therefore it is the American grower who must chiefly be satisfied at the present time. The sudden removal from the market of American-grown cotton would completely upset the whole trade.

We must now go on to consider how best to attain this highly desirable aim of stability in price, and at the same time we may

consider the probable effect upon Empire cultivation of the present low prices, the two questions being closely interwoven, and the encouragement of Empire cultivation the chief end in view.

For the last sixty years the production of "bread-and-butter" cotton has been a practical monopoly of the United States of North America, and one which has not been seriously abused, though subject to the inevitable disadvantages of monopolies. One of the chief of these is that cultivation in one country only must render the crop liable to great variation, for in general the whole crop will be more or less subject to similar conditions of climate, pests, labour troubles, etc. Nearly a quarter of a century ago these facts so strongly impressed a number of far-sighted men that they founded the British Cotton Growing Association to encourage the cultivation of cotton in the wonderful variety of countries, climates, and conditions that may be found within the British Empire. After many years of hard work, their foresight is now in a fair way to be crowned with full success; the cultivation of cotton in the Empire is at length assuming considerable proportions.

Monopoly of a crop by one country cannot be considered as a good thing, for many reasons; but "single crop" cultivation is equally little to be desired, and both should be done away with so far as is practicable, the one by extension of cultivation into different countries, the other by the introduction of variety and rotation of crops. The full carrying out of both these programmes seems to us the one really satisfactory way at present open of achieving the great end in view, that of the stabilization of the price of cotton at the lowest possible figure. So long as cultivation is confined to one country, so long will a bumper crop tend to be followed by undue restriction of area, with its corresponding undue rise of price; and so long as any one country depends almost entirely upon cotton for its income, so long will that country be in an unstable financial condition, and liable to violent fluctuations in prosperity. Extension of cultivation and variety and rotation of crops are equally called for.

Extension must be into countries with as much difference in climate and other conditions as may be practicable. So great is the variety within the Empire that there may some day be little need to look outside of it, as already it produces almost every kind and quality of cotton that is known. The chief lack is that of a suitable climate in the north temperate regions, and this is already supplied in full measure by the United States, which will probably long remain the chief producer of cotton. In the present condition of the cotton market, when the coming season is almost certain to be marked

by a considerable restriction of area and rise of price, the more that the cultivation of cotton within the Empire can be extended, the better for the great aim of stabilization of the price.

But extension of cultivation is not enough. In some countries cotton is the only, or the principal, string to the financial bow, and this is also an unsound position. Cotton should not be the only crop, but should be supplemented by others, and if in a regular "rotation of crops" this will be all to the good, helping to stabilize the production of cotton in that country, reducing the liability to pests and diseases, rendering the peasantry less liable to the troubles of fluctuation of price, gaining the advantages of rotation, making the revenue of the Government more stable, and so on.

The grower will be hard hit by the present low prices, and in view of the fact that the bulk of the growers are still within the United States, the rise of price that is practically certain to follow will have to be enough to satisfy them—say perhaps 2d. or 2½d.—bringing the price of American middling to say 8½d. or even 9d. But though we may have to allow the price in the near future to reach such a figure, there is no reason why we should endeavour to stabilize it quite so high, for we have every right to suppose that a large part of the Empire growers can produce cotton profitably at a lower rate. The price of most of our cotton is at least 1d., sometimes 2d., above that of American middling, while the cultivation, within the tropics at any rate, is usually a "family" affair, each family cultivating a small area, and doing the whole of the cultivation and picking themselves. Under such circumstances the return obtained for the crop, less the cost of seed, etc., is looked upon as profit, and the actual cost of production is very small. The plantation industry of cotton will be very hard hit by the low prices, but the village industry should survive, even though the cultivators may be sadly puzzled to know why the price should have fallen so greatly from the halcyon days when they provided themselves with so many luxuries. The villagers still require money for taxation, and for the things that have now become more or less necessities to them, and cotton will provide them with this money, even if the price be comparatively low.

The present bumper American crop is practically certain to be followed by a restriction of area by the growers, that will mean a reduction of some millions of bales in the coming season (*cf.* Todd's figures in this Journal, Vol. II., p. 143, where the crops usually fall on an average 3 millions of bales after each year of very low prices, with an average rise in price of nearly a penny). And this restriction will give to the Empire growers such a chance as they have never

yet enjoyed of getting a firm footing in cotton production. They should step in now, and fill as much of the gap in production as they possibly can. The prices of next season will probably be remunerative to them; we have already indicated that most of them can produce cotton more cheaply than can many other growers; and, consequently, when the next bumper (world) crop arrives, it should not be they who will have to restrict, so much as their competitors. Their position as large producers will be assured, and a great step will have been taken upon the road to stabilization of cotton prices.

In the present state of the cotton market, it is of the highest importance to encourage our Empire growers to produce all that they can, but this is only the immediate necessity. Until they cease to depend upon one crop, and until cotton takes its proper place in a rotation of several crops, the position will not be quite stable, and much effort should be devoted to the careful study of the possibilities of other crops and of rotations.

While the cheap costs of production, and the higher prices obtained for Empire cotton, are great assets, the position will be much strengthened by careful attention to the other side of the balance sheet—the lowering of the cost of placing the cotton in Lancashire. Above all, cheap transport is the most crying need; it is at present more expensive, and less efficient, than in America, though it is true that, on the other hand, the cotton is handled by fewer middlemen. Improvement and cheapening of the means of transport are the most urgent problems lying before those who wish to see great developments of the cultivation in the Empire. Ginning and other processes also require to be improved and cheapened, and there is still room for an improvement in the quality of the cotton. Even in a bad market there is never any difficulty in disposing of cotton of really good quality. Lancashire is perpetually tending to spin finer qualities of cotton, and wants all that she can get of these qualities. As Mr. Ormsby-Gore said at a recent meeting of the Council, the future is going to depend upon our turning out a cotton that is always at least 2d. on American middling; if we only produce a thing as good as the latter, we shall have a very bad time.

Various schemes are under discussion for ameliorating the position of the growers, but as these can only be put into operation by countries like the United States, that have the bulk of the supply in their hands, they have only an academic interest for us, though their adoption may be cordially welcomed, as they all act to the good of the growers in outside countries, as well as within the lands

of their origin. Such are valorization—the taking off the market in a bumper year of a considerable portion of the crop, and its marketing in a later year of short crop. This is practised by Brazil in coffee, and is about to be put into operation with the American cotton crop of the past season. It makes for stabilization of prices, and is all to the general good. Another is restriction of crop, as applied to rubber, but this, with an annual crop like cotton, is hardly practicable. Yet another is reduction of area. which is usually practised by the growers themselves, and which will probably happen this year in the United States. As already pointed out, this gives to our growers, who can produce cheaply, the greatest opportunity that has yet come their way, and every possible advantage of it should be taken. In this connection a quotation may be made from a *Times* editorial of last October:

"Clearly the world grows rich by the production of wealth; the unworked seam and the untilled field have potential rather than real value. The invention of a new machine which increases mankind's power of production adds to the productive wealth of the world, and enables a larger quantity of products to become available for consumption. It means, in short, that the inhabitants of the world have more to share, and so long as there are rivers to be bridged, railways to be built, or roads to be made, the work of the world is not done. So long as there are human beings insufficiently clad and ill-nourished the work of the world is not done. The difficulty is that we have not yet succeeded in creating perfect machinery for the distribution of the products of industry, and so, while farms are unprofitable and fields are untilled children go hungry; while spinners, weavers, and tailors are out of employment unfortunate persons shiver with cold.

"Obviously there is something wrong, but unfortunately the trouble has not yet been correctly diagnosed, and no real remedy has been found. Hence it comes about that an insufficient demand for goods—which in reality means that those who need them have not the purchasing power to obtain possession of them—results in factories working at less than full pressure, and many persons are out of work. Unfortunately an increasing number of persons think that the remedy for bad trade is to be found in limiting output to the existing demand. It is quite true that limitation of output may result in remunerative prices, but it is apparently not seen that the effect of restriction of output is necessarily cumulative. The fact that fewer persons are employed entails further restriction of the

demand for goods, higher cost of production per unit, and so on, in a vicious circle leading ultimately to greater poverty and distress. Years ago a well-known writer, and others of his way of thinking, occupied a great deal of our space in endeavouring to prove that the remedy was what they termed the creation of credit, but we have seen where currency inflation led in the case of Germany, and there is every reason to suppose that currency inflation in any other country will have the same effect in the long run. But the failure of this gentleman and his friends to solve the problem is not a reason for adopting a policy of despair which is fundamentally unsound. Wider vision is needed. We do not profess to have a ready-made scheme that will result in better distribution of the world's products, the stimulation of demand and general prosperity, but we are certain that, although restriction of output may in particular cases sometimes be justified as a temporary expedient, it can never afford a real remedy for present economic evils."

In conclusion, to enable the growers to take full advantage of the present position, some assistance may in certain cases be necessary, but such assistance must come from their local government, which is fully conversant with the local difficulties. It is up to local authorities to decide whether, for example, reduction of taxation, special cheapening of costs of transport or of ginning, the supply of free, or cheap, seed, or other assistance may be necessary, and whether the general conditions of the country will allow of such assistance. An admirable example of what may be done is offered by the new sliding scale of taxation upon cotton in Uganda (*cf.* p. 72).

To sum up, the present low prices will test severely the possibilities of cotton cultivation in the Empire, but to our growers is offered such a chance of establishing themselves in a very strong position as will rarely come their way. Already they can produce more cheaply, and are turning out a cotton of better quality, and they should now try all they know to fill up the gap in production which is all but certain to follow the present excess. They, and those who are engaged in assisting them, must do all that they can to improve quality, and to lessen cost, and to find other crops that can be employed in rotation with cotton. The greater the success that attends these operations, the greater the progress that we shall make on the road to the desirable goal of stabilization of cotton prices. At a recent meeting of Council, Lord Derby remarked that the large American crop of the present season had reduced prices to a level which could not have been foreseen a few years ago. Though this fact might

cause a setback in the acreage under cotton in the Empire, he thought that where cotton was grown by natives on small plantations, this setback might not be prolonged. The need for a money-producing crop was becoming increasingly felt by African natives, and they might learn from the drop in price that only improved methods of cultivation could ensure to them a sufficiently high yield per acre to bring them a good return for their labours. He emphasized the advantages which Lancashire might expect to derive from their continued support and encouragement of the cotton-growing industry within the Empire.

We may end by urging (if indeed it needs urging) upon spinners and manufacturers alike that a whole-hearted support of Empire cultivation was never more necessary than now, nor was it ever more likely to lead to results that will be eminently gratifying to all who are concerned in any way with the production of cotton within the Empire.

MANCHESTER'S RAW COTTON MARKET

BY

HARRY ROBINSON,

Secretary Manchester Cotton Association.

ANY account of the Manchester Raw Cotton Market would be incomplete without reference to the position of Manchester as the centre of the greatest textile area in the world. The business men of Lancashire attend daily on the Manchester Royal Exchange (the membership numbers over 11,000), and transactions are made resulting in Manchester cotton goods being exported to all parts of the world.

Historically, it is only a few years ago that the cotton trade was for all practical purposes dependent upon one port and one market for its raw material. A change took place with the making of Manchester a port in 1894—a port which is the most economic point for the importation of the raw material and the exportation of the manufactured article. This great inland port made it possible for the industry to effect important financial savings in transit and handling charges.

HOW MANCHESTER SURMOUNTED DIFFICULTIES.

Manchester had a great advantage over the old ports, for it was constructed upon the most modern lines, so that cargo should be subjected to a minimum of handling. At the outset it was realized that unless concerted action were taken, old customs and vested financial interests would prevent the cotton trade securing the benefits which the new port made possible, hence the formation of the Manchester Cotton Association in 1894. The Members are cotton merchants, cotton brokers, and cotton spinners, the last-named controlling over 33 million spindles.

In the first season (1894-95) 66,000 bales of raw cotton were landed at the Manchester docks, whereas last season, notwithstanding trade depression and the fact that the American mills were running roughly only 50 per cent. of normal, there were landed at Manchester 683,608 bales. That cotton could come in bulk to Manchester compelled other ports and the railway companies to reduce their charges.

Thus Manchester, besides providing the cheapest route, has benefited the industry all round.

Prior to the development of the Manchester cotton market the spinner was compelled to go to Liverpool to buy his cotton. What is the position to-day? Liverpool merchants and brokers, realizing that they would lose business by reason of the headway being made by Manchester, are now to be met with each business day on the Manchester Royal Exchange, whilst many, owing to the changed conditions, have offices in Manchester. It is one of those inevitable changes due to the economic position of Manchester and to this great city being the hub of a vast industrial area, for within a radius of fifty miles there is a population of 10½ millions.

Manchester, after London, is the greatest commercial centre in the British Empire. The magnitude of the trading transactions is borne out by reference to the Bankers' Clearing House Returns, which show that in 1925 the bankers' clearings in Manchester exceeded the combined clearings of the banks of the five towns outside the metropolis, and nearest to Manchester in banking importance—namely, Liverpool, Birmingham, Newcastle-upon-Tyne, Bristol, and Hull.

An idea of the immense quantity of raw material required and the volume of manufactures produced can be visualized when it is realized that in the towns adjacent to Manchester there are 58 million spindles (one-third of the world's total) and 786,000 looms. Apart from the requirements for domestic consumption, the exports of cotton piecegoods last year amounted to 4.433 million square yards.

Some of the leading organizations having their headquarters at Manchester are the British Cotton Growing Association, the Federation of Master Cotton Spinners Associations, the Cotton Spinners and Manufacturers Association, the Textile Institute, the British Cotton Industry Research Association, the Fine Cotton Spinners and Doublers Association, the Bleachers Association, the Calico Printers Association, and the following banks have their head offices in Manchester: Williams Deacon's Bank, Ltd., Lancashire and Yorkshire Bank, Ltd., District Bank, Ltd., County Bank, Ltd., Union Bank of Manchester, Ltd.

Manchester gave a great impetus to the purchase of cotton upon c.i.f. terms—merchants selling raw cotton to spinners upon cost, insurance and freight terms, and so satisfactory has been this business that disputes are practically unknown. Mills buying upon these terms, and having the cotton shipped to the Manchester Docks, effect economies in transit and handling charges, for buying upon

recognized types and from reliable houses, there is no question of wrong deliveries, and the terms of payment often give the spinner the advantage of receiving the cotton and spinning it into yarn before maturity of the bills. Also, in this style of purchase the spinner, if a Member of the Manchester Cotton Association, can effect a further important saving by not incurring brokerage.

The Manchester Cotton Association has framed Rules and Contract Forms for the various styles of purchase. The trading rules of Manchester are similar to those of Liverpool, though in the case of disputes arising there is one outstanding difference in the Manchester Rules, as a Member of the Manchester Cotton Association can, if he so desire, appoint a Spinner Member to arbitrate for him. Also, on the Appeal Committees, the Members are composed of sellers and spinners. This is not the case with Liverpool, where all arbitrators are cotton merchants or brokers. Under the circumstances, buyers and sellers are more and more making their contracts subject to the Manchester Rules.

Apart from the savings which the cotton mills can effect on their c.i.f. purchases, delivered via Manchester, the mills can also secure important savings in the matter of "spot" cotton—there is economy in time, also Manchester "spot" cotton means less haulage and expense, for taking Oldham, where roughly one-third of the Lancashire spindles are situated, the distance from the Manchester dock warehouses to Oldham is eight miles, whereas from Liverpool to Oldham it is thirty-seven miles. Then a mill taking a load of cotton from Manchester does not send its motor light, but delivers yarn on the way to the docks.

Up to the present Manchester has received only a small percentage of the "Empire" cottons, though its economic position should be fully investigated by the shippers of these growths, especially as the Manchester merchants are in a position to offer facilities for the financing and handling of these cottons.

The mills using Egyptian cotton had more than half of their requirements landed at the Manchester Docks last season (1925-26). American and Indian cotton also is shipped in bulk to Manchester.

The Directors of the Manchester Cotton Association consider that the competitive market and port of Manchester are of the greatest value to traders, and Manchester's economic position is a guarantee that its market will become increasingly important.

COTTON IN SWAZILAND

BY

R. CECIL WOOD,

Cotton Specialist in Swaziland.

The pleasure experienced in setting to work in a new country, under new and probably strange conditions, is in part discounted by the foreboding that sooner or later, and in all probability sooner rather than later, one will receive a request from the Secretary for a contribution to the Journal about it. It is as well to get it over; and this must be my excuse for writing an article on cotton in Swaziland after such a short acquaintance. Perhaps less courage is needed to undertake such a task after six months than after twice as many years. One writes, it may be, with more freshness of view, though the critic is more likely to refer to one's hasty judgment.

To begin right at the beginning. Where is Swaziland, and what position does it occupy in the Empire? A glance at the map of South Africa will show certain areas excluded from the Union, and of these Swaziland is one. It is not large—with an area of about 6,700 square miles, it is roughly the size of Wales—and is situate east of the Transvaal, which surrounds it on three sides, while it is bounded on the east by Portuguese East Africa and Tongaland, now part of the Natal Province. It lies between the eastern slopes of the Drakensberg Mountains and the low-lying lands of the coast, and may be roughly divided into three steps, which mark this descent. The uppermost region (4,000 feet) is mountainous, misty, and of little value for arable cultivation, as the country is too broken, but it is suitable for stock or dairy farming and fruit culture. As we travel eastwards, the country falls away into the rounded slopes of the middle veld, at an elevation of about 2,000 feet, and here a considerable amount of cultivation is to be seen—mostly maize, with some cotton on the lower or more sheltered portions. Eastwards again, this rolling country subsides into the levels of the low veld, actually a level plain, the Lebombo Flats, at an elevation of about 500 feet, and bounded on the east by the massif of the Lebombo range, whose western face rises precipitously to 1,500 feet, though the eastern slopes afford some rich lands which appear in places quite suitable for cotton. It is on the Flats and the lower slopes of the middle veld, and in the valleys

which often penetrate far into the mountainous country, from which the rivers debouch on to the plains, that the prospects of cotton growing are best. The Flats extend to a breadth of some twenty miles, and similar country, lying below the Drakensberg, extends northwards to Komatipoort, and on up to the Spelonken area (*vide* map in Keatinge's Report of 1923), and southwards as far as the Tugela River. The accompanying figures will give some idea of the change in the country from west to east:

	Elevation (Feet).	*Mean Temperature.* *Summer (Degrees F.).*	*Mean Temperature.* *Winter (Degrees F.).*	*Rainfall (Inches).*
Mbabane ..	3,500	67	57	52
Bremersdorp ..	2,000	72	62	38
Natalia Ranch ..	700	79	62	25

The country is administered under the Colonial Office and the High Commissioner by a Resident Commissioner, whose headquarters are at Mbabane. The Swazis moved into the area about 1820, and mostly occupied the middle veld country; the low veld was comparatively unknown until recently; it was considered unhealthy, and it suffers from a lack of water. The present Administration dates only from 1906, and was ultimately brought about by the many concessions which had been granted by a former king: these concessions were then duly defined and the native areas delimited. The present situation is that rather more than one-third of the territory is native area, and the remainder owned by the State or by Europeans.

The country suffers from lack of capital, both public and private, with the result that there are large areas almost entirely unproductive. Swaziland is an out-of-the-way corner of the Empire, and looking at the map one cannot help feeling that the obvious solution of its trouble lies in absorption by the Union. The question is one which is of some importance at the present time, and interest is kept alive by occasional references, inspired or otherwise. The country also suffers from lack of communications, though a railway is now approaching its southern boundary, and the possibility of having a line of railway through the country is alleged to be bound up with this question of absorption in the Union. It is a country of rumours; the rival suggestions of an east and west line, linking up the Transvaal with Goba, the present terminus of the Portuguese Railway, which would serve the high veld sheep farmers who find pasture for their flocks in the middle veld during the winter months, or a north and south line, ultimately joining Komatipoort with Durban, are frequently discussed, now one and now the other being considered as settled.

Progress in road-making is fair, considering the small amount of traffic the roads carry, and in dry weather one can get from end to end of the country without much difficulty, though little has yet been done in the way of providing all the year round roads by the use of metal and the construction of bridges.

The production of cotton is at present entirely in the hands of the white man, African or European. The question of its cultivation by the native is not yet practical politics; the native expresses no desire to do so, and the matter may be left at that. The farms held by white farmers are, speaking generally, of two kinds, which have this in common, that they are, usually, of a considerable size. There are the older concessions, wholly or partially developed, leased to individuals or to companies engaged in cattle ranching, with intermittent attempts at cultivation on a larger or smaller scale, and often running in extent to many thousands of acres. There are signs that these are breaking up, and the increasing number of settlers, especially in the low country, makes it more probable that settlers will be found for the smaller farms which are being carved out of these areas. In the middle veld, either these concessions were smaller originally, or have been divided since; the country has been longer occupied, and the farms, some of them, under cultivation for comparatively long periods. Besides these, there are in the low veld large areas of Crown lands which have been divided up into farms and allotted on easy terms to tenants, most of them men who had served in the war. Some of these have been cleared of the fairly heavy bush which covered them, and occupied, and it is pleasing to relate that some of these new settlers are making good, an ambition in which they are much assisted by the activities of the "1820 Settlers" organization. The process of settlement is proceeding satisfactorily, and even the few months the writer has been in the country have seen considerable progress. Further areas of Crown land remain for allotment in due course.

In a similar way the farmers fall roughly into two classes, the old and the new. There are the old stalwarts, pioneers many of them, dating back to before the Boer War, who have seen the country develop; many of these, especially in the south, are Dutch. The younger brigade comprises the new settlers, many of them ex-officers, and the younger representatives of the families of the older residents, who are growing up to take their fathers' places. Many of the Dutchmen are to be found farming land on shares with its owner, who may have other interests, or who may have more land than he can farm himself, or can, under present conditions, sell at what he

thinks a reasonable price. Farms are, as has been said, on the large side, and tend to be scattered, so that the farmer leads, in consequence, a life of solitude, though in some areas, where settlement is closer, and the land less covered with bush, it is possible for a man to see two or three of his neighbours' houses. Living is plain, mealie meal and chickens bulking largely in the ration, for butchers' meat is unprocurable and game not over-plentiful. The water difficulty, too, is a very real one, and the regular supply for the farmer and his work-people, dependent as it sometimes is on a sledge or a cart which may have to bring every drop of water from five or six miles away, is a constant source of anxiety.

A word may be said about the advent of the cotton-growing company, which is so much more common further south in Natal, but of which there is one example in Swaziland, Cotton Plantations, Ltd. The company has only recently started work, and its profit-earning capability is at present an unknown quantity, but its activities have, directly or indirectly, done a great deal to open up the area in which it is at work, and a post office, a telephone line, and a ferry have already resulted.

So much for the farmer; what of the labour he employs? It is mostly recruited locally, for the Swazi has a good many wants to be satisfied, as well as a fairly heavy tax to pay, and is prepared to work for hire for definite periods. One hears a good deal of complaint about him, but he is probably no worse than most, though he does seem to be uncertain. It is commonly said that no sooner has a boy (this means an adult labourer) been trained to carry out a particular job than he leaves service. Be this as it may, from the farmers' point of view, the labour of the country is spoilt by the mines, which take the pick of the men and pay them at rates which the farmer cannot afford. The pernicious system of advances has also a firm hold on the country, and these may be paid and spent months before the man comes up for work. The Swazi is a fine and virile type, who can readily be trained, but with an unfortunate weakness for intoxicants. He wears as much as he can get in the way of civilized garments, and considers it the correct thing to carry, besides his spear and sticks, a small looking-glass, and a mouth organ or concertina. That he is not devoid of intelligence may be gathered from the fact that he is commonly to be seen using a big iron mould-board plough, with two or three span of oxen, which he has adopted entirely of his own free will, and which he buys himself at the local store, whence he also obtains the necessary new shares. Such a state of things is bound to be noticed by one who, for so many years in

India, struggled to persuade the ryot to adopt even a small iron plough, and with so little success.

When the farmer has produced his cotton, there remains still the problem, often the greatest one of all, of moving it to the ginnery or to a railway. Produce in Swaziland is moved centrifugally, going north to Komatipoort, east to Goba, west to Breyton or Moolman's siding, and now, south to the extension of the Durban-Somkele Railway, which is gradually pushing up, and which, by the time these words are in print, may have crossed the Pongola River. But the distances to these railways are great: Bremersdorp is over 100 miles from Carolina on the west, and 70 from Goba on the east. The farms on the Hloya and the Ingwavuma have to send over 100 miles to the siding, though the new railway will improve matters for them enormously. And it must be remembered that these long distances hit the farmer twice over, for not only is it expensive for him to get his produce away, it is equally costly for him to get his implements, stores, and spare parts. The efficient and up-to-date little ginnery at Bremersdorp, run by natural water-power from a local stream, has thus proved a great boon to the cotton-grower in this locality.

The ox-wagon is the conveyance of the country, supplemented by the donkey-wagon, especially where quarantine regulations for cattle are in force. The motor-lorry has recently made its appearance, and there is a regular service from Carolina to Mbabane, but the steep descent from the latter precludes its serving Bremersdorp. Mention may also be made of the sled, a heavy forked beam, towed by its apex, which the native uses commonly to transport firewood, and which is not despised by the white man. It is an undecided point whether its use improves or spoils a road.

The present production of cotton in Swaziland is, it must be regretfully stated, insignificant. The statistics for the last few years are as follows:

1919-20	.. ..	274	bales of 500 lbs.
1920-21	.. ..	183	,, ,,
1921-22	.. ..	95	,, ,,
1922-23	.. ..	244	,, ,,
1923-24	.. ..	522	,, ,,
1924-25	.. ..	427	,, ,,

The 1924-25 season opened well; prices were good, and the weather up to March most favourable. Very heavy and continuous rains fell after the beginning of March, and the crop suffered severely, so that much of it proved a complete failure. There was a considerable reduction in the area planted to the crop effected by those who had suffered, but this was probably more than made up for by the new

settlers, and it is likely that the production this year will surpass that of 1924-25. The season has been a dry one, favourable for cotton but not for maize, and those farmers who, in disgust at last year's failure, gave cotton a miss, have learnt the lesson that salvation lies in a system of mixed cropping, and will not risk all again on a single crop. At the same time, prices are low at present, and with the prospect of another heavy crop from America, do not show signs of recovery, so that cotton is not a popular crop for the coming year (1926-27). Still, it has shown its value in a dry year, and speaking generally good farming has resulted in a good crop. It is to be regretted that there is much farming that is of a low standard, but this is only what may be expected in a community many of whom have only recently settled on the land, and have no farming tradition behind them. Naturally, in a country where holdings are large, and most farmers have more land than they can deal with properly, one does not expect the standard of farming that obtains in a closely settled country, but the use of unsuitable implements—and the disc plough is responsible for much inferior cultivation—and the non-recognition of the value of time as a factor in producing a good tilth, makes much of the energy expended by the farmer of less value than it might be. Writing in June, there is astonishingly little land to be seen which has received even a preliminary tillage for the coming season, and if it is replied that the land is now too hard to plough, the answer is, surely, that it should have been ploughed up in the autumn (January to March).

This, however, is a digression. The position may, I think, be stated briefly thus. The Swaziland farmer must adopt a much greater variety of crops than he had in the past, partly because it is good agricultural policy not to risk too much on a single crop, and partly because the advent of a railway, "if and when and always supposing that" it comes, will alter the present relative value of commodities, and certainly reduce the value of his present staple crop, maize. Among such other crops cotton stands easily first, from its capability to withstand drought and its intrinsic value—so long, that is, as a reasonable yield and a reasonable price can be assured. If a heavy American crop forces the price down this year, it may be anticipated that America will go out of the business of cotton-growing, wholesale, with a corresponding recovery in price. There remains the question of a reasonable yield; good crops have been recorded, but owing to jassid, bollworm, stainer, and other insect pests, the crop is rather speculative. The remedy for this is two-fold: the use of jassid-proof seed, and this can now be assured, and

the adoption of adequate precautions, if necessary enforced by legislation, against the multiplication of the other insect pests. While a sudden expansion in the cotton area is not, therefore, anticipated, there seems little doubt that, as soon as prices recover, Swaziland will from year to year show a steady increase in her production of cotton, to her own material prosperity and the general welfare of the Empire.

Received July, 1926.

THE WORK OF THE SHIRLEY INSTITUTE IN RELATION TO COTTON-GROWING

BY

F. SUMMERS

THE last two years have seen a considerable increase in the number of persons interested in cotton-growing who have paid visits to the laboratories of the British Cotton Growing Industry Research Association at the Shirley Institute, Didsbury. These visitors have been drawn principally from two classes. The first of these, composed of those who have had actual experience of cotton in the field, has included directors of agriculture and other officials concerned with the organization of cotton-growing in the colonies, cotton specialists, cotton breeders, and a sprinkling of mycologists and entomologists engaged in countering the attacks of the numerous fungi and insect pests of the cotton field. Of these the majority have been furnished by the agricultural departments of those colonies in which the growth of cotton is being pushed with special vigour.

The second group has been almost entirely made up of young university graduates holding studentships for advanced study or research awarded by the Empire Cotton Growing Corporation. These students spend two or three weeks in the Botany Department of the Institute before proceeding to the Imperial College of Tropical Agriculture in order further to qualify as recruits in the rapidly growing corps of scientific workers on the various problems connected with cotton-growing.

It is in very great measure due to the policy and activities of the Corporation that the amount of personal connection between cotton-growing in the field and technological research in the laboratory has been raised from a negligible quantity to its present satisfactory dimensions. At the present moment, in almost every cotton-growing territory of the Old World, there are agricultural officers who have had personal experience of the aims and methods of the Research Association, while, on the other hand, the members of the staff of the Association have become acquainted with the problems and difficulties of a considerable number of field workers. Personal contact of this nature cannot fail to be of advantage to

both from an educational point of view, as well as to cotton-growing and research within the Empire.

It may be of interest, therefore, to describe certain aspects of the scientific work of the Research Association which are of special interest to growers of cotton and of direct assistance to visitors of one or both of the categories described above.

It should be mentioned that, even at the inception in 1917 of the idea of a great research association for the cotton industry of Great Britain, the members of the Provisional Committee charged with the furtherance of this object were far-sighted enough to anticipate that one section of the activities of such an association would be concerned with the institution of an intellectual and scientific liaison between the cotton grower and the spinner. It was recognized that facilities for the exchange of ideas between the producer and the consumer of raw cotton were almost non-existent, so that the former, concerned almost exclusively with such aspects of his work as yield and ginning out-turn, had no clue to any special requirements of the spinner relative to the characteristics of the cotton hair itself. Furthermore, no common language existed in which the spinner could specify his difficulties or requirements to the grower, or the latter could indicate the possibility of meeting or overcoming them. The scientific study of the production of cotton lint suffered under an almost similar handicap, for the plant breeder, working on the problem of lint improvement, was not in a position to secure early and reliable information as to the possibility of a market being available for the product of his selections and crosses. Moreover, like the professional grower, he had no means of obtaining from the spinner precise indications of the desirable features of cotton lint from his point of view.

Botanists and agriculturists working with cotton were fully aware of the anomalies of this situation, an admirable exposition of which was given by Balls in the first chapter of his "Handbook of Spinning Tests for Cotton Growers." He pointed out that, at the time of writing, the only possible course was to allow the cotton breeder to produce whatever he could, confining his direct purpose to agricultural merits, and, when a sufficient quantity of lint became available, to subject this to a spinning test which would decide whether his labours had been fruitless or not. Balls looked forward to the time when the spinning test would be supplanted—except as a final corroboration—once it was possible to correlate the spinning properties of a cotton sample with the measurable characters of the individual cotton hairs.

The investigation of this relation has formed an important section of the botanical work of the Shirley Institute. The first phase of the work has consisted of the working out of methods for the determination of the measurable characters of the hair, including length, width, and wall thickness, breaking load or strain, and weight per centimetre length. Secondly, in connection with each method, it has been necessary to determine a procedure for taking a representative sample of the bulk to be tested. Cotton hairs show such variability of dimensions that, generally, at least 250 hairs must be measured before a reliable mean value of any character can be obtained.

Both classes of visitor find much of interest in this section of the work, for it has been the aim throughout to make the methods sufficiently simple for employment by workers of the laboratory assistant type, and under tropical conditions where laboratory facilities are usually somewhat elementary. The result is that the methods are now almost "fool-proof," necessitating, as they do, patience and accuracy only.

Space does not permit of a full description of each one. Length and width are measured under the microscope, but the former can also be measured by stretching the hair on a graduated glass scale coated with liquid paraffin. Wall thickness is measured from camera lucida drawings of transverse sections obtained by the special method of section cutting developed in the Botany Department, while hair weight per centimetre is determined by weighing on a quartz fibre micro-balance bundles of centimetre lengths cut from a sample of hairs. The older method of measuring the breaking load or strain of single hairs by means of O'Neil's apparatus has been supplanted by employing the Magazine Hair Tester invented by Balls. Considerable saving of time is effected by this machine, which, although eerie in its functioning, is almost irritatingly simple in principle and design. Before its adoption breaking-load determinations controlled the rate at which measurable characters could be investigated. Now the work can be so speeded up that all the characters of one sample can be investigated simultaneously and *at the same rate*, a factor of great importance in work of this type.

It is the general practice, so far as time permits, for those interested to try out the above methods for themselves. The research students do this with the object of applying them later in the field, while visitors of the first class have in mind the adoption of the methods and installation of the special pieces of apparatus in the laboratories of experiment stations under their charge. As

a result of these trials and of discussions between them and members of the staff of the Botany Department, not only is uniformity of method now ensured in all places where the measurable characters of the lint are being investigated, but it will be possible in future for workers in this field to obtain valuable checks on the validity of their conclusions. Formerly it was impossible to obtain these checks, which are so very desirable in the early stages of an investigation of this character.

Another satisfactory result of these trials and discussions is the fact that the methods under consideration may now be regarded as sufficiently standardized for present-day purposes. They have been adopted by the large majority of cotton research workers, and the Institute type of micro-balance, accompanied by the Baer Sorter referred to below, is rapidly following the Balls Sledge Sorter into all centres of research on cotton lint. The outlook for the future, therefore, is eminently satisfactory so far as concerns the improvement of research methods, the accumulation of data bearing on lint properties, and the improvement of liaison between research workers in the field and in the technological laboratory.

In addition to methods based upon the accurate measurement of large numbers of hairs, others are in constant use in the laboratory. For example, the method of obtaining staple length diagrams by means of the Baer Sorter is regarded as one of the greatest utility to workers in the field. A " Baer diagram " gives a pictorial representation of the relative frequencies with which hairs of different lengths occur in a given sample. This is not only valuable for purposes of comparison, but can readily be interpreted, not only by grower and spinner, but also by the layman. This is a point of great importance when it is necessary to demonstrate to a non-technical or non-scientific audience the result of a field experiment. Moreover, a " Baer diagram " shows the lint exactly as it is affected by the setting of the spinning machinery for converting it into yarn, while the diagrams of two different cottons will show at once whether they can safely be mixed for spinning purposes—a question which spinners have very frequently to decide. At the same time, " Baer diagrams " ought to be of great assistance to the grower and breeder. They can readily be produced by semi-skilled workers; they can be interpreted without laborious measurement or calculation, and, furthermore, when photographed, constitute a convenient record of the result of a selection experiment or plot trial.

In view of the current interest in the measurable characters of the cotton hair it may be appropriate at this point to give some

indication of the progress which has been made in their investigation. The latter has taken the form of subjecting a large number of cottons to a spinning test in the mill concurrently with the determination of their measurable characters in the laboratory. Almost every well-known type of cotton has been so tested, and not only have the ordinary cottons of commerce been included, but also many samples forwarded by the Empire Cotton Growing Corporation. These latter have been received from Colonial agricultural officers desirous of a practical test of their experimentally produced lint immediately the supply of this is great enough for the purposes of a spinning test. Other samples have come from India, while Egypt has contributed amongst her quota some of the highest grade pedigree cottons grown by the State Domains Administration.

When a cotton is received in the laboratory it is first of all sampled for the various measurable character determinations. Following this, the yarn specifications to which the cotton can be spun are decided and a mill selected which can most conveniently work to these. The actual spinning is carried out under the supervision of a member of the research staff, specially qualified for this class of work, and, when the yarn is finally delivered, it is subjected to the usual tests for strength and elasticity in the Testing Department of the Institute. Here visitors are able to see the tests being carried out, and to learn the functions of each testing machine. In this manner they gain some impression of the forces which a cotton yarn has to resist in practice, and the manner in which the quality of the raw cotton affects the ability of the yarn to withstand them.

It was originally expected that, after the investigation in this manner of a large number of widely differing samples, it would be possible to classify them either on a basis of their measurable characters or of their spinning properties, and from such a classification obtain some indication of correlation between the two. This expectation has not been realized, and it has become obvious that each character must be studied singly if the nature of its relation to spinning value is to be elucidated. Moreover, evidence has been forthcoming that the various characters differ in order of importance, the first in order being probably lint length and hair weight per centimetre. The latter has been given priority, and an extensive series of cottons, possessing the same staple length but differing in hair weight, has already been spun in the preliminary stages of a mass attack on the problem of the relation of hair weight to spinning value.

In other directions of research, measurable characters have proved

EMPIRE COTTON GROWING CORPORATION

An increase in the number of sources of supply of raw cotton is a matter of the most urgent importance; it is hoped, therefore, that all those interested will aid the Corporation in their endeavours to extend the cultivation of cotton within the British Empire. They can assist in this direction by making the work of the Corporation as widely known as possible, and for this purpose it is hoped that subscribers for the Journal will be forthcoming from all cotton-growing parts of the Empire.

A Subscription Form is attached.

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of considerable value. For example, by means of them it is often possible to identify a cotton, not only in the raw state, but also in the fabric or yarn in spite of subsequent bleaching, mercerization, or dyeing. Examples of the employment of measurable characters for identification purposes are briefly described in a paper by Morton (*Journ. Text. Inst.*, 1926, 17), which, forming as it does the first serious attempt to determine the industrial value of one of these characters, should be found of great assistance to all interested in lint properties. There is little doubt that further investigations and experience will greatly increase their value for research purposes. For example, it has been found that the hair weight bears a direct relation to the depth of shade when the resulting yarn or fabric is dyed. This practical point is of great importance to both grower and spinner. A low hair weight is generally to be connected with a thin hair-wall, which again is characteristic of immature or badly developed lint. A vast amount of trouble and financial loss is caused yearly by the presence of immature cotton in the bale. Immature hairs are normal in length, and hence difficult to remove before spinning. Consequently, they are spun into the yarn along with their normal fellows, and remain unnoticed until after this is dyed, when they announce their presence by giving rise to streakiness or unevenness of shade in the fabric of which the yarn is a component. This may lead either to the rejection of the fabric by the customer or a monetary claim on account of the delivery of a material which is below standard.

On this account, efforts are always made to impress visitors with the importance to Empire cotton of reducing to a minimum the amount of immature material in the bale. Its presence is often due to careless or out-of-season picking, and an excess usually characterizes the produce of native small holdings in the early stages of development of a new cotton-growing area. The prevention of an undue proportion finding its way into the ginnery presents considerable difficulty, involving as it does an amount of supervision both there and in the field, the provision of which is usually beyond the power of an agricultural department. Nevertheless, it is of the highest importance that no Empire cotton should ever gain a name in the industry for containing a high proportion of immature hairs, and, on this account, it is the practice to provide for visitors an assortment of samples showing the effect of immature cotton on various processes of spinning and manufacture. An investigation of these readily convinces them of the seriousness of the problem, and it is to be expected that subsequent missionary effort in the

field on their part will ultimately lead to Empire cottons occupying an advantageous position in this respect.

Visitors of the second class who have as yet no experience of cotton-growing are able, during their stay, to make some slight acquaintance with the cotton plant, for, in the hothouse attached to the Botany Department, about 100 plants are grown, primarily to furnish material for a laboratory investigation of the morphology of the cotton hair. The greater number, therefore, are of a single variety, Acala, which has been found by experience to grow normally and successfully under the prevailing conditions. Unfortunately, while temperature and humidity are, within limits, controllable, the duration and amount of sunlight are not, so that while most Indian and American varieties grow well, Egyptian and Sea Island varieties are far from successful. In spite of this, a sufficiently wide range of varieties is available to afford, with the help of Watt's "Wild and Cultivated Cottons of the World," a useful introduction to the systematic botany of the cotton plant. This is supplemented by elementary physiological observations and, later, under the Economist, by discussions of the controlling factors in the distribution of cotton-growing—that is to say, of the bearing of climate and irrigation, and of the significance of general economic considerations.

It might on first thoughts be supposed that work on the morphology of the cotton hair would have slight bearing on cotton-growing. Far from this being so, this chapter of botanical research never fails to interest visitors, if only from the severely practical standpoint that methods of utility in laboratory diagnosis have emerged from what appeared originally to be work of an academic nature. For example, a by-product of the investigation of the cuticle of the hair is the Congo Red method (Bright, *Journ. Text. Inst.*, 1926, 17), by the aid of which it is possible to determine the degree of deterioration suffered by cotton under attack by heat, acid, micro-organisms, or mechanical action. This method has recently been applied (Clegg, *Journ. Text. Inst.*, 1926, 18) in the investigation of the character of yarn breakages, for which purpose no suitable method had previously been available, and in estimating the amount of weakening and mechanical damage which cotton hairs undergo in the processes preparatory to spinning.

Again, recent work has shown that, when young, the hairs in the developing boll are coated with a syrupy substance rich in sugars. As growth proceeds the quantity of syrup decreases until, when the boll is due to burst, it has reached vanishing-point. It would be surprising if the presence of this sugary material had no relation to

the susceptibility of the boll to insect and fungus attacks. Actually, in the greenhouse, boll rots are occasionally caused by *Aspergillus niger* attacking the base of the boll near the bracteoles, where frequently the syrup can be found oozing out in drops. There is a prospect that future work on the sugar and tannin contents of the boll may not only throw light on its susceptibility, but also bring out points of interest to the plant-breeder in connection with resistance to pests.

Work on mercerization might equally well be supposed to be remote from contact with that of the cotton grower, but, in reality, this is not quite the case. In the measurable character work it has been found more convenient to measure the width of the mercerized hair rather than that of the convoluted hair of the bale. As there is a ratio between the two widths the latter can easily be calculated once the former is determined (Calvert and Summers, *Journ. Text. Inst.*, 1925, 16). Further, as the mercerizing quality is an important property of all cottons of a staple suitable for converting into yarn for mercerization, methods of investigating the mercerized hair are of practical significance to the grower. Hairs which are ill-matured generally have subnormally thickened cellulose walls which, during mercerization, are incapable of producing optimum swelling in the caustic soda solution. During washing and drying their subsequent shrinkage is irregular, leading to inferiority of the final mercerized product.

The cumulative effect of practical demonstrations of the above kinds is to convince the cotton research worker of the supreme importance to the industry of a well-grown, regular, and clean-picked crop. This theme is elaborated by the Economist, who discusses with the research students the relative importance of uniform quality and regular quantity as compared with high quality and great quantity. Uniform quality, governing as it does the processing of cotton from the bale to the fabric, must always constitute the chief consideration of the producer of " outside growths," and it is chiefly in the laboratory, through the investigation of the morphology and measurable characters of the cotton hair, that the clearest view is obtained of the many directions in which uniformity must be sought.

The last main section of the work of the Botany Department is concerned with the damage caused to cotton goods by " mildew "—that is, the growth of the commoner mould fungi such as Aspergillus, Cladosporium, Fusarium, Penicillium, and Rhizopus. This is a problem of great economic importance, especially in fabrics exported

to the tropics. But the cotton grower is rather concerned with the development of mildew in raw cotton and yarn, which is often considerable under certain conditions of treatment and storage. It may often be due to ordinary atmospheric infection, but, in many cases, it arises from an initial infection of the raw cotton in the form of spores and fragments of mycelium. It is clear, therefore, that the greatest vigilance ought to be exercised in order to prevent infected cotton from reaching the gin.

Two reasons are therefore assigned for waging incessant warfare against pests in the field, for not only is the yield of the crop involved, but the quality of the lint as it reaches the spinner. Strong opinions are often expressed in the trade as to the relative liability of certain cottons to mildew, but, up to the present, no conclusive evidence has been forthcoming, either from long experience in the mill or from scientific investigation, to show that any one class of cotton is more liable than another. Liability must, however, depend upon cleanliness and amount of initial infection and, as it is of the greatest importance that no Empire cotton should acquire a doubtful reputation in this respect, the work of the cotton mycologist assumes additional importance on this account.

In conclusion, as the investigation of the characters and properties of cotton lint can only be regarded as still in its infancy, a plea may be entered for the greatest degree of co-operation between workers in this field. It is only as a result of such co-operation that the grower will be enabled to understand the needs of the industry, and the technologist be able to appreciate the potentialities and difficulties of work in the field. It is gratifying to think that Empire cotton serves as a basis, and the Empire Cotton Growing Corporation as the necessary machinery, for securing this co-operation, and it is hoped that the stream of visitors to the Shirley Institute may continue to flow as long as its laboratories are able to make their contribution to this object.

Received November, 1926.

THE NATIVE COTTON INDUSTRY AND ITS RELATION TO RURAL ECONOMY IN THE BRITISH COLONIES OF EAST AFRICA

BY

H. C. SAMPSON, C.I.E.

In order to establish the native cotton industry in the British Colonies and Protectorates of East Africa on a sound basis, it seems necessary among other things to review the present position.

Where cotton has been found to thrive and to produce a crop of sufficient value to encourage the native to grow this, a very large share of the energies of the several Agricultural Departments concerned has been employed in extending its cultivation. There is no doubt that very large areas of virgin land have been cleared with the sole object of growing cotton. In some localities this has been carried to such an extent that very little uncleared land is available for further extension of cultivation. So eager, indeed, have the natives become to grow this crop that the question of their growing sufficient food-stuffs for their own requirements has on occasion given the Administration anxiety.

The wholesale cultivation of a single crop such as cotton may have results which are not to the ultimate advantage of the increased production of this commodity, though it may cause temporary satisfaction in that it helps to meet the world's demand for cotton. The native, who has heretofore been accustomed to supply his own simple needs from what he grows and from what he can collect out of the bush, is, by growing a crop such as cotton, suddenly placed in what is to him a position of affluence, and this may lead to disastrous results. An exaggerated example of the effects of such sudden affluence on the native is quoted by Sir F. D. Lugard in the case of the native cocoa industry of the Gold Coast.*

"The Governor of the Gold Coast (Sir H. Clifford) remarked that 'cocoa is notoriously one of the least exacting forms of permanent cultivation known to mankind.' The natives would probably not have undertaken it otherwise, 'or any task of the sort that made a more severe demand on their physical energies.' It is admitted that

* The Dual Mandate of British Tropical Africa.

even that small amount of exertion has not been given to it, and a danger of fungoid and other diseases on the 'indolent and slovenly farms' is the result. The quality, too, is very inferior for lack of proper care and trouble in the preparation. The rush for large profits in cocoa has replaced the more laborious palm-oil industry, and the haste to get rich without toil has resulted in a serious shortage of food, and the destruction of irreplaceable forest lands in the search for virgin soil. The cocoa farmers, we read, have become indolent, and the work is left to the women. Boys despise labour, and have a horror of manual work. Maize and other native food has now to be imported. Another result has been to enhance the cost of labour to such a degree that there is great difficulty in carrying out public works and private undertakings. These conditions are increasingly evident in the Lagos hinterland also."

Such conditions are inevitable to a certain extent in tropical Africa on account of the high costs of transport, which in the early stages of the development of the country only admit of the carrying of commodities that have a high value on the world's markets for a restricted bulk of produce; they are already evident in Uganda, where it is reported that there is now difficulty in obtaining labour for public works and for the ginning and handling of the cotton crop, on account of the sudden wealth that the natives have obtained by growing cotton.

The case of cotton is not, however, in any way so serious as the case just quoted. In the first place the regulations in force throughout British East Africa make it compulsory that cotton be treated as an annual crop, and that the old crop be uprooted and destroyed before the next year's crop is sown. In some parts also, where the Agricultural Departments are sufficiently staffed, the cultivation of cotton is carefully supervised, and care is taken to see that the preliminary as well as the after cultivation is attended to. Where land is available, however, the tendency is for the native to grow a much larger area under cotton than under his food-stuffs. The area of the latter is only sufficient to satisfy his own requirements. It thus follows that it is not possible for the native to grow his cotton in rotation with his food-stuffs to any great extent, and the tendency is for him to look upon his cotton patch as distinct from the area where he grows his food-stuffs. The results of this are either that cotton is grown on the same land year after year without any rotation, or that cotton lands are abandoned and fresh areas are cleared for this cultivation. The tendency in any case is for the abandonment of old cotton gardens for new land as time goes on, since continuous cultiva-

tion of cotton on the same land year after year will in time reduce the yield so much that it is no longer profitable to grow.

Then, again, there is always the danger of the spread of disease, and this is much more likely to occur where cotton is grown year after year on the same land without rotation. This is especially the case where that dreaded pest—the red bollworm—occurs, as the larva of this pest pupates in the soil and, in spite of regulations for the destruction of the old crop, emerges next season to attack the freshly planted crop. Such causes as this may have a considerable effect on the rate of permanent expansion of the cotton area. Another cause which may affect the expansion of cotton is the price paid for the seed cotton. Since the war the fluctuations in the price of cotton have been greater than they have been in many other commodities, and as the market for manufactured cotton goods is intensely sensitive to the fluctuations in the price of the raw commodity, the demand for cotton piece goods has never been normal since the war. A combination of a reduction in price and a reduced acre yield is very likely therefore seriously to affect the even expansion of the production of Empire grown cotton.

It may be said that this is an alarmist view, and that in many parts of the American Cotton Belt cotton has for long been the predominant crop, and yet yields have not suffered to any great extent. Even under boll weevil conditions there, it is still possible to obtain crops which will yield over a bale to the acre. This certainly is possible with intensive farming methods, but the position in tropical Africa is very different. Here frost is of rare occurrence, and even if it occurs it is not severe, nor is the ground wet when it does occur. Frost is the main insecticide in America, and if it were not for the winters there the boll weevil would long ago have wiped out the cotton crop as it has done in Florida and along the Atlantic Seaboard, where the winters are mild.

For these reasons it appears essential, if the rain-fed cotton industry in tropical Africa is to be laid on a sure foundation, that more definite ideas of farming be inculcated among the growers.

The farming, such as it is, should be made more elastic, and the native grower should be encouraged to grow alternative crops, not only to maintain his financial position when prices of cotton are unremunerative, but also to enable him to vary his cropping and thus help to conserve the fertility of the soil. Maintaining the fertility of the soil by manuring is possible only to a very limited extent under present conditions. The pastoral tribes who own cattle are not as a rule agricultural, and of course in the "fly"

country manure from livestock is hardly obtainable, since only a few sheep and goats are kept.

The question of maintaining the fertility of the soil is one which, up to the present, has not given the native any concern. When one plot of land has become exhausted, it has in general been the practice for the native to abandon the old clearing and make a fresh one. One does not notice the effects of this on the richer soils and the valley alluviums, where land will continue productive for a long time; but where the natural fertility of the soil is not very great, such a system very soon denudes the countryside of its forest growth, and it is within the memory of Europeans resident in these countries that the whole aspect of the countryside has been changed by the denudation of forest growth following abandoned native cultivation. It may be said also that the entrance of European influence into these countries has greatly hastened this process, as this has effectively put an end to slave raiding and intertribal wars, which formerly were the main checks to the increase of the population. The increase of the population will further be hastened in the future by the increasing attention which is being given to the treatment of disease, child welfare, and sanitation. With the spread of education also, and by the penetration of traders into the country, the wants of the people will be greater and their standard of living will be raised. In order to meet this the native will have to produce more, for it is mainly by the sale of his produce that he can get the wherewithal to meet his growing needs. The effect of all this will be greater pressure on the land, and this in its turn must mean better farming.

The present system of native farming, if it can so be called, is not peculiar to East Africa. It is a subject which has received serious consideration in Ceylon, and in India, where a similar method of cultivation is common among the hill tribes. It has been realized that such a system of fugitive cultivation is a serious menace to the forests of the country, on which the climate, rainfall, and soil fertility so much depend. In these countries every effort is being made to get the people permanently settled on the land, and presumably it is only a matter of time before the same problem must receive the increasing attention of the East African Administrations.

The main essential to the introduction of better farming methods among natives is a definite individual tenure of the land that they cultivate. Without this there can be no real incentive to improve the property and to maintain the fertility of the soil. This is generally recognized as a *sine qua non* by those who have the future development of British Tropical Africa at heart. Since in most cases land

in cultivation and land available for cultivation is Crown land, there seems to be no objection to granting titles to individual holdings other than the expense of having these demarcated. The native in many parts of these colonies has seen this method adopted in the case of lands alienated to settlers and others, and it is not new to him. Such a procedure would no doubt form the basis of taxation in the future; for as the native progresses it is evident that some other form of taxation must in time take the place of the present hut tax. In this connection there is much to be said for the system of land taxation adopted in the case of *ryatwari*, or Government land, in British India. Sir F. D. Lugard criticizes this tax on the grounds that it has been based on the average value of the average yield of the land. This is certainly a just criticism under present conditions in East Africa, because the commercial crops which the natives can grow are so limited in variety. Thus a low yield or a low price for native grown cotton might make such a tax too severe a burden on the native's resources; for it must be borne in mind that the ordinary food-stuffs of the natives have as yet a purely nominal value. In parts of Nyasaland, for example, maize has been known to be sold locally in inaccessible areas at 24 pounds for a penny. Until, therefore, the native has a wider range of commercial crops which he can market, any land taxation must be small compared to the acreage cultivated.

Besides the question of land tenure, there are other difficulties in the way of evolving a sound system of farming. It is of little use advising the native to practise a rotation of crops if such crops cannot be disposed of by him. Suppose, for example, that a native at the present time grows 2 acres of cotton and 1 acre of food-stuffs for his own requirements. It is obviously of little use advising him to grow 1½ acres of each. The additional food-stuffs could not be disposed of except by utilizing them for making native beer, and there is more than sufficient of this already made as it is. The difficulty is mainly one of transport. Much has been done in the past, and more is intended in the future, to open up these countries with railways, but even if these do exist the native is tremendously handicapped in his markets. This is in a large measure due to the sparseness of the population, and therefore its inability to produce sufficient of any ordinary commodity to justify the railways charging a reasonable freight rate. Besides this, also, there is the cost of getting such produce to the railway. As regards railway freight rates, it must be remembered that most of these railways have been, and are being, built with the help of borrowed money on which interest has to be

earned, and unless the railways can earn the interest on this, then the money has to be found from the general revenues of the country. Thus it is that only such products as can bear high freight rates can at present be exported. The volume of traffic in any commodity decides what freight rates this can carry, and one has only to compare the freight rates on the Indian railways with those on the African railways to realize what an immense difference a dense producing population makes to the cost of getting the products of the country to its markets. One has also only to compare the variety of exports from a country such as India with those from Africa to realize how at the present stage of her development Africa is handicapped in the variety of marketable crops which she can grow.

Of the crops produced by the native cultivator in East Africa and exported there are very few. Besides cotton there is a limited trade in groundnuts, sesamum, and chillies. From the Sudan there is an export of dura, from Tanganyika a certain amount of robusta coffee, and from Nyasaland an increasing quantity of tobacco, while from the coast there is an export of copra. This list does not furnish much choice for forming a suitable rotation for cotton, and it is very doubtful whether any rotation could be made from these crops which would not in a short space of time impoverish the soil to too great a degree.

Where, however, cotton has become an established crop, there seems to be an opportunity of extending this list of exportable crops. Cotton, at the prices which have been ruling until quite lately, has been able to carry quite a heavy freight rate on the railways, and, in cases where these are Government railways, there seems to be no reason why some of the increasing profits earned by the carriage of this commodity should not be utilized for subsidizing, as it were, the export of less valuable commodities. For, after all, such railways have been built for the development of the country, and it is therefore much preferable to increase revenue by such indirect means, than by taking railway revenue into the general revenue of the colony. An instance of such a subsidy rate is to be seen in the very low rate which the Uganda Railways have been able to give for export maize from Kenya and Uganda. Such a low rate would probably have been impossible, until the bulk of the maize traffic increased very considerably, but for the traffic earnings of the railway derived directly and indirectly from the cotton crop of Uganda.

Granting that the difficulty of railway transport will ultimately be overcome, there is still the further difficulty of advising the natives what crops they can grow as rotation crops for cotton. This

is a matter for investigation by the Agricultural Services on their Agricultural Stations. The ordinary crops of the natives of Africa are, with few exceptions, similar to the dry land crops of India. It is likely, therefore, that other crops now grown in India and not grown in Africa would do equally as well as those now being grown, when once they have become acclimatized. However, there is sufficient material already in Africa to make a start. The principal dry land cereals are the same as in India. Many of the pulse crops are similar, and possibly have advantages over those grown in India, as at least two of these are already known on the European markets. Of oilseeds there are already those which have previously been mentioned—namely, sesamum and groundnuts. Fibre crops as such are probably unknown, as there is already such a wealth of wild fibre plants in Africa that the native can always get what he wants for his own requirements from plants growing wild. Surely there is sufficient range of crops here to make a start, and to obtain definite data concerning methods and costs of cultivation and the yields likely to be obtained. There is also the necessary enquiry to be made in Europe to find out what are known there, and, if unknown, to bring these to the notice of the consuming public. There is no doubt that Africa can produce many commodities which could be utilized, in some cases as human food, and in others as feeding stuffs by European farmers. A greater range of the latter than at present exists would go a long way towards reducing the cost of feeding livestock, and ultimately in reducing the present high cost of living.

In this way it would be possible to make farming much more elastic so that, if for one cause or another any particular crop does not for the time being pay to grow, the native has some alternative crop to take its place. He would then be in a position to take up this crop again when conditions were once more favourable, and this, without letting the land revert to bush.

Received November, 1926.

THE PATHOLOGY OF THE COTTON PLANT IN NIGERIA

BY

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The object of the present article is twofold. Firstly, it serves in a measure as a report upon progress and, secondly, it is an attempt to clarify the present position with regard to cotton diseases in Nigeria.

From the year 1912 onwards isolated observations have been made upon various cotton diseases in Nigeria, while more recently several papers have appeared upon new diseases and functional disorders or upon new aspects of older diseases: the present article attempts to link up these past observations, to incorporate the more recent work, and to introduce some kind of order into the present complexity by grouping the diseases into classes according to their apparent relative economic importance. The diseases, then, are classified into three groups, the major diseases, the diseases of intermediate or local importance, and the minor diseases. It must, of course, be clearly realized that such a classification cannot, from the nature of the case, make any claims to complete accuracy or finality, and that it is liable to modification as knowledge increases. It does, however, establish a point around which future investigations may be orientated.

There is probably little doubt that those diseases classed here as major diseases are major both in the sense of their effect upon the plant and of their distribution throughout the country: similarly the minor diseases appear to have a negligible effect upon the plant, though they are probably widespread. It is more especially to the diseases of intermediate or local importance that criticism should be directed. On the one hand, it is not to be supposed that each disease is likely to be uniformly distributed over a country so vast and so climatically varied as Nigeria, while, on the other hand, it must be emphasized that our experience of them is parochial. Further, many of the diseases in this group are of recent discovery (*e.g.*, Crinkle, Leaf Roll, and the Alternaria disease), and of their varying incidence from year to year little is known. It must, then, be realized that our knowledge of this group in particular is at present extremely fragmentary.

THE EFFECTS OF THE DISEASE UPON THE COTTON PLANT.

Before the rôle of any particular disease can be thoroughly understood, and its importance assessed, it is necessary to grasp clearly the various ways in which it is possible for a disease to affect the cotton plant. There are probably few plants upon which it is more difficult to assess damage due to disease than cotton, for reasons which appear below.

Two widely different kinds of disease may at once be distinguished—the diffuse, in which the effects of disease are diffused over the whole plant as an entity, and the local, in which the effects of disease are strictly localized either on (*a*) the *plant body* (leaves and stems), or on (*b*) the *potential fruit* (flower-buds, flowers and bolls), or on both. The diffuse type of disease need not here be mentioned further, but the effects of the local type must be examined more carefully.

(*a*) The effect of a local disease on the *plant body* is a loss of photosynthetic area. This might at first sight appear trifling, were it not for the fact that damage to the manufacturing plant body is reflected in losses of potential fruit produced.[9] There is, however, another factor to be considered, which raises even the common cotton saprophytes to a position of importance. The leaf is often a suitable pabulum for the growth of weak parasites, and, when injured by insects, etc., for secondary parasites and saprophytes also: such minor parasites are, then, enabled to produce enormous amounts of infective material (spores) while growing on the plant body, and these sources of potential infection may, and often do, affect the potential fruit either directly or indirectly (by insect puncture, etc.). Edgerton,[2] for instance, in 1912 showed that many general weak parasites and saprophytes, as well as the primary parasites, are able to cause internal boll rotting when they are introduced into a boll. (These general boll-rotting fungi must not be confused with the peculiar specific "Fungi of Internal Boll Disease." belonging to the genus *Eremothecium,* which were first described by Nowell[12] in the West Indies.)

(*b*) The effects of local diseases upon the *potential fruit* (flower-buds, flowers, and bolls) are various, owing to the peculiar physiological reactions of the cotton plant.

Diseases may cause the potential fruits either to shed or to become wholly or partially aborted and "mummified" *in situ,* the age of the potential fruit at the moment when the disease lesion reaches a significant magnitude deciding which of the two processes shall occur.

Mason,[9] working in the West Indies upon Sea Island cotton, demonstrated the dynamics of shedding, showed the influence of external and internal factors upon it, and emphasized the part played by disease, etc., in promoting shedding. The shedding of flower-buds by the agency of disease is not itself of great moment, since cotton plants normally produce more flowers than they are able to mature. The shedding of young bolls is more serious, but even here 30 to 60 per cent. of the young bolls may be shed from physiological causes. As a corollary, then, it is clear that if a certain percentage of shed bolls shows the lesion of a disease, it does not follow that this percentage of shed bolls remains on the plant when the disease is absent: how far the total shedding is thereby reduced will depend, *inter alia*, upon the distribution of the disease among the plants, for it may happen that the disease, acting externally and precisely upon the plant, merely selects which *particular* bolls shall be shed, and so replaces the more diffuse selection normally exercised by internal physiological factors.

Referring again to Mason's work, it will be seen that young bolls become progressively less liable to shedding seven or eight days after the flower stage. If bolls are injured at this stage, then they are not shed, but abort and mummify *in situ*. Should the injury be situated at the base of the boll, the further development of the boll is, sooner or later, inhibited: an autolysis begins, usually at the tip, spreading downwards, and leads ultimately to a hard "mummied" and entirely valueless boll. On the other hand, if the injury is not seated at the base of the boll, the damage which results from injury is confined to parts of the boll, and so causes partial loss.

Symptoms.

When considering the pathology of an organism, it must always be borne in mind that symptoms are the product of the properties of the host and the properties of the parasite, and in this connection there are two symptoms which deserve notice, since an undue weight is often assigned to them.

When a cotton plant dies or is killed, the plant juices begin to turn red (black in mass), the red substance being a product of the host—*i.e.*, the cotton plant itself. Reddening and blackening, then, in so far as it is a symptom, is a symptom of death, which may, or may not, be associated with a parasite.

Then, again, the angular shape of lesions on the leaf is not of great diagnostic value. Several cotton parasites produce "angular

spots" on the leaf—for example, the bacterial disease and the Areolate Mildew. This again is a property of the host rather than of the parasite, and is the consequence of the angular depressions on the underside of the leaf, themselves caused by the arrangement of the minute leaf veinlets. That this is the case is shown by the fact that on other parts of the plants (flowers or stems) the lesion of the bacterial disease, for example, is circular or oval in shape. It is confirmed by the fact that if cotton plants are sprayed with a fine mist of a lethal solution, such as a strong paraffin soap emulsion, lesions of an angular shape, indistinguishable in size and position from those caused by the bacterial disease, develop on the leaves. Further, if a leaf of the cotton plant is injected artificially with water, "waterlogged" areas of angular shape appear.

Susceptibility of Different Species to Disease.

In Nigeria three main types of cotton are grown: American plants belonging to the species *hirsutum*, and native plants belonging to the species *peruvianum* and *vitifolium*.

Farquharson,[3] in 1912, first pointed out that American plants were more immune to fungous diseases than native. Mason and Jones,[10] in 1924, showed that this was applicable to the bacterial disease also. Recent experience has shown that the American plant is more immune to all parasitic diseases, whether of fungous, bacterial, or virus nature, except in those cases in which the disease is insect-borne, where the problem may be complicated by the greater attraction[10] which American plants exercise over native.

With regard to the functional disorders of "Crinkle" and "Leaf Roll," Wright and Mason[15] have shown that "Crinkle" is peculiar to the native type of cotton, and that the disease probably owes its origin to an inability of the subsoil to supply water. On the other hand, "Leaf Roll," which is probably associated with too great a supply of moisture in the soil, is more serious on the American plant than on the native.

Diseases of Major Importance.

1. *Internal Boll Disease.*—This disease affects the older bolls by local injury, so that the damage caused can be easily and directly assessed. Internal boll disease, or more correctly internal boll diseases, affect the older cotton boll in two ways, depending upon the time of infection. If infection occurs early in the history of the boll, the seeds are disorganized and softened, and the lint fails to develop

normally, is very weak, and is often stained. Such seed cotton is entirely valueless. If infection is late, the lint already formed is stained and weakened: such seed cotton is saleable, but is classed in a low grade, and commands a correspondingly diminished price.

These diseases have been dealt with more fully by Laycock.[8] Considerably more than half of the ripe bolls may, not unusually, be rendered quite useless by these diseases in Nigeria.[10, 11] The correlation of the incidence of these diseases and of the stainer bugs has again been demonstrated. The fungus named by Nowell,[12] species Type C, has been shown to be present, a species of *Fusarium* has been shown to be capable of causing a boll rot when introduced into a boll, and it is probable from the work of Edgerton[2] that many other fungi and bacteria are also involved.

It is tolerably clear that the only means of control at present practicable are based on the control of vectors, the cotton stainer bugs; at present, then, the control of these diseases is an entomological problem. In this connection it is worth notice that the *native* varieties suffer less severely from these diseases, a fact probably explicable by the greater attraction of the American plants for the vectors.

2. *Bacterial Disease.*—The causative organism is the bacterium *Pseudomonas malvacearum*, E.F.S., which causes damage both to the plant body and to the potential fruit. It was first noted in Nigeria by Farquharson in 1912;[3] he called it the "black vein" disease, though he did not associate it with *Pseudomonas malvacearum*; it is probable, therefore, that a part at least of the damage said to be caused by anthracnose at that time was really due to *Pseudomonas malvacearum*, followed by a species of *Fusarium*—a parallel to West Indian experience.[13] Thornton,[14] in 1922, next reported what he considered to be *Pseudomonas malvacearum* from the Ilorin district, and since then it has been found to be generally distributed in Nigeria; it is common in the Oyo Province (south-east), and specimens have been received from Kano, Zaria, Ilorin (north), and Umuahia (south-west).

Considering, at first, cotton grown in pure culture (plantation conditions) in the Southern Cotton Belt,[5] the damage to the plant body (angular spot) may amount to a loss of mature leaf area of 15 per cent. or even more for the native cotton, while damage to the stems ("black-arm") may be considerable.

On the potential fruit the disease ("boll rot") may cause shedding up to 5·4 per cent. of the flower-buds for American cotton, 14·8 per cent. for native cotton; boll-shedding may amount to 12 per cent.

and 18·7 per cent. respectively of all flowers produced, while mummied bolls may cause losses of 0·7 per cent. and 4·8 per cent. respectively of the potential crop.[10] In addition to this damage, there is unassessed damage caused by the disease acting as one of the "internal boll diseases."[2] More recently Mason and Wright[11] have concluded that the disease, by causing damage to the plant body, was one of the most important biological factors upon their experimental plots in the Oyo and Abeokuta Provinces.

All the figures given above tend to show that under plantation conditions in the Southern Cotton Belt *Pseudomonas malvacearum* does cause considerable damage and economic loss, which should be controlled or prevented. Control of *Pseudomonas malvacearum* is possible by means of seed disinfection, which is now practised in America, the West Indies, and the Anglo-Egyptian Sudan. A disinfection experiment on $\frac{1}{10}$-acre plot at Ibadan, using the method Faulwetter[6] recommends, gave complete control throughout the season. Further large-scale experiments on comparable plots are, however, necessary before any reliable conclusion can be drawn either as to the control of the disease or to the increase of crop which is presumed to follow when the disease is absent.

As regards the disease under plantation conditions in other parts of Nigeria, little exact information is at hand, and only general impressions can be gathered from information and specimens sent in from out-stations. Summarizing this type of evidence, it seems probable that in the Northern Cotton Belt[5] the disease is active on the plant body, but, with the end of the rains and more especially the onset of the extremely low humidity caused by the "harmattan" wind, its spread is arrested, and little, if any, damage is caused on the potential fruit. In the Middle and Southern Cotton Belts[5] much the same phenomenon obtains, but both rainfall and humidity drop more and more gradually as the coast is approached, so that considerable damage may be caused to the potential fruit.[10, 11] In the extreme south of the Southern Cotton Belt, the disease appears to be of practically no importance. The reason of this is not clear, but it is possible that it is the result of the considerably higher mean temperature which obtains here during the cotton-growing period, since it is known that the disease is unable to infect the plants at a high temperature. Much further evidence must, however, be collected before the importance of the disease throughout Nigeria can be ascertained.

On native-owned cotton farms the problem is by no means so simple. The amount of disease which is present on a cotton plot

depends on three factors: the amount of infection carried by the seed, the conditions which allow of infection and spread, and the proximity of the cotton plants to each other. Now the native farmer often adopts a system of mixed cropping, which causes the cotton plants to be more widely spaced, and this would, *a priori*, tend to diminish the spread of the bacterial disease. The effect of mixed cropping on the disease cannot, then, be determined solely by observation of such native-owned cotton plots, because there are the three factors involved and the relative value of each cannot be determined; as far as observations extend, it is exceptional for the bacterial disease to be an important factor on native-owned farms.

3. *Leaf Curl* (*Virus*).—This disease was first noticed by Farquharson in the Ishan country in 1912,[3] and was more fully described by him in the following year.[4] It has since been found in widely separated areas (Zaria, Ilorin, Ibadan), so that it probably occurs throughout Nigeria.

The disease appears to be one of the group of maladies known as "virus" diseases, whose main characteristic is that the infective principle is filterable through porcelain filters without loss of infectivity.

The disease affects the whole plant, the leaves are abnormal and often chlorotic, flowering is restricted, while there is some suggestion of sterility. The number of plants affected is often large, but the incidence of disease is closely connected with the time of year. A further account of the disease is being published elsewhere.[7]

Diseases of Intermediate, or Local, Importance.

1. *Anthracnose* (causal organism *Colletotrichum gossypii*, South.).—Damage is normally caused both to the plant body and to the potential fruit, but in Nigeria damage to the plant body is rare, if not altogether absent—a not unusual feature of this disease.[1]

The fungus was considered in 1912[3] to be the most important cotton disease in Nigeria. But, as before mentioned, there is little doubt that a great deal of this damage was in reality due to the bacterial disease followed by other fungi of secondary importance. Recent experience[8] of this disease has been varied, and it seems tolerably clear that incidence differs greatly from year to year. It is possible that the more severe incidence in certain years is to be correlated with the occurrence of severe "harmattan" weather with its accompanying low night temperatures. In more normal seasons it appears that the disease causes little damage.

No definite evidence with regard to its primary parasitism is available as yet.

2. *Leaf Roll.*—This disorder, which affects the whole plant, appears to owe its origin to abnormal physiology, and may therefore be suspected to occur whenever the predisposing conditions are encountered. American plants are much more severely damaged than the native. The leaves are the chief parts affected, but boll-shedding is very pronounced; recovery occurs on the return of more favourable conditions. An excessive amount of moisture appears to be the chief predisposing condition for the development of the disease.

It is at present difficult to assess the importance of the disease, since it is of very recent discovery. A further account is being published elsewhere.[7]

3. *Alternaria Disease.*—Although the fungus is probably widespread, it appears that the damage it causes becomes considerable only in certain humid areas.

Damage is caused both on the plant body and on the potential fruit. On the leaves the fungus produces circular, brown, "zoned" spots which do not usually exceed half a centimetre in diameter; such direct damage is very rarely significant.

On the potential fruit this disease is able to cause bud-shedding (rarely), boll-shedding, and boll "mummification," while in most cases such damage is small; yet in humid areas *Alternaria* may be responsible for almost half of the total boll-shedding in damp weather, and an unknown, but probably considerable, amount of boll "mummification." A further account of the disease is, however, being prepared.

4. *Crinkle (Physiological).*—This functional disorder, which was described and investigated by Wright and Mason[15] on native cotton from the Ibadan area, was found by them to be of widespread, though localized, occurrence. Eighteen plots spread over a wide area gave an average of 22 per cent. of affected plants, the individual percentages of which ranged from 96 to 0 per cent.; American plants were not affected.

It was found that there was a correlation between the hygroscopic coefficient of the subsoils and the amount of Crinkle present on the plants; the authors, therefore, favoured the view that Crinkle was possibly due to "the inability of the subsoil to supply moisture at a rate high enough for the normal functioning of the leaves."

Diseases of Minor Importance.

1. *The Areolate Mildew* (*Ramularia areola*, Atk.).—This is one of the commonest of the cotton fungi, but it seems to cause negligible damage; the old and dried-up lesions on the leaves are liable to be confused with those caused by the bacterial disease.

2. *Damping Off.*—This is caused by the fungus *Sclerotium bataticola* (the "Rhizoctonia with small sclerotia" of Dr. Butler);[1] it occurs in rare cases, more especially in colder weather.

3. *Rust.*—*Kuehneola desmium*, Arth. (*Uredo gossypii*, Lager) has been reported from cotton: it causes negligible damage.

4. *Cercospora gossypii*, Atk.—This fungus has been connected with small spots on American cotton.

5. *Fusarium sp.*—A species of *Fusarium* is extremely common as a saprophyte on cotton, and may cause much secondary damage;[8] the *Fusarium* wilt of cotton has not yet been encountered.

Acknowledgments.

The writer wishes to thank Messrs. A. G. Beattie, R. F. Martin, H. Roebuck, T. Thornton, D. H. Urquhart and H. B. Waters for their kindness in sending information and specimens from outstations; he is greatly indebted to Dr. T. G. Mason and Mr. C. H. Wright, who have repeatedly brought to his notice anything unusual on their cotton plots in the Oyo and Ilugun areas, and he wishes to thank Dr. Mason for much helpful criticism. Finally, he wishes to acknowledge the help and encouragement rendered by Dr. E. J. Butler, F.R.S., Director of the Imperial Bureau of Mycology.

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Received March, 1926.

FOLK-LORE FRAGMENTS—I

BY

J. C. MAY.

THE Native Commissioner signed his name, added the date, blotted both, and heaved a sigh of relief. The last case before the Court had been disposed of, and it was half-past one on a Saturday afternoon. Now for lunch, and a start shortly afterwards for Isungwe, the camp at which he had decided to spend the week-end.

The crowd of principals, witnesses, and onlookers started to melt away, their voices rising louder and louder the further they got from the quietening atmosphere of the Court-house, probably the one place on earth in which they would ever learn to be silent.

"Sergeant, see that Swewe has some food, and we will start at 2.30," said the Commissioner, rising and smiling at Swewe, his best friend amongst the Chiefs of his district. "Indio Bwana," replied the Sergeant of Police, saluting smartly and then bending forward to fold the Union Jack that had been draped over the Court-house table; Ben, the interpreter, was already vanishing into the office with the Court books.

Picking up his helmet from beside his chair, the Commissioner walked through his garden to his bungalow, shouted "Boy—food," washed, and sat down to his lunch at a table on the verandah. As he ate he cast his mind back over the events that had led up to his proposed visit to Isungwe.

Each full-grown native male has to pay a hut tax, and it is by no means easy to provide the natives of an undeveloped district in Central Africa with the means of paying their taxes. The Watali in the plains had been induced, the year before, to grow more rice than they needed for food, and a nice little export trade had been developed. The Wasoko in the hills to the west had been urged to try tobacco, and though their curing left much to be desired, still he had been able to persuade European buyers to take the last season's crop at quite fair prices. He had still been faced with the question as to what could be done with the large belt of country that lay between, that had no flooded areas suitable for rice and yet seemed too low-lying for tobacco. He came to the conclusion that he

must try cotton, and in this the Agricultural Department had done their best, with a limited staff, to help him. The advantages of a "money crop" had been preached, and the necessity for cultivating extra land in readiness for the seed, for the supply of which he had arranged. The reply had been fairly satisfactory, and then one day two tons of cotton-seed had arrived from the Director of Agriculture and had been dumped in the large store-room. Next the women had started to come into the station to receive the seed that their lords would plant, and the necessity for moving twenty bags of it from the store to the market had arisen, for it was impossible to dole it out in the narrow space in front of the store. The Commissioner laughed to himself as he recollected the scene. He had gone to the Court-house where the usual crowd of idlers was assembled; the Armistice had just been signed, the Colony was soon to be renamed Tanganyika Territory, and many cases that would normally have long been settled still awaited hearing. He had said that he wanted twenty volunteers to carry seed from the store to the market, and that each would receive a handful of salt. The moment before he spoke there had been some forty natives, who had sunk on to their haunches once again after rising to greet him. The moment afterwards there had been a rush of feet, and a cloud of dust as they fled at the prospect of a little work—all that remained were two minor headmen, whose dignity did not allow them to run, an old man who could not run, and an aged crone whom he strongly suspected of being stone deaf! So the prisoners had to be sent for from the prison garden, where they were preparing the land for the maize crop that would later help to feed them or their successors; twenty bags were carried to the market and the necessary seed given out. A notice was then posted on the Court-house wall to the effect that no more cases would be heard until a further twenty bags of cotton-seed had been carried from the store, and the police and station staff were instructed to tell all comers of what had happened and of the Commissioner's decision.

Next day he had had a most peaceful time; no lawsuits to hear, and much arrears of office work had been disposed of. The day after some seven or eight natives had arrived, but on hearing the news said they were too few to carry twenty bags; a second day of peace, and though a certain amount of seed was distributed to the women who had come in to fetch it, the twenty bags that had been carried to the market by the prisoners had not been exhausted. On the third day, however, the Sergeant of Police came up to the house at 7 a.m. to say that a large number of men had arrived to carry bags in order

that the Court might be reopened; for the African native enjoys nothing so much as engaging in, and listening to, litigation.

The Commissioner had let them wait until 8 o'clock, his usual hour of arrival at the office, and had then been confronted by a large crowd, amongst whom he recognized several of the runaways, looking distinctly ashamed of themselves. "You wish to carry seed bags?" inquired the Commissioner; "Indio Bwana," was the united cry. "I want twenty bags carried to the market," continued the Commissioner. "Indio Bwana," rose from lips that were now all smiles. Handing the key of the store to the Sergeant, the Commissioner told him to give out twenty bags, and he himself hurried to the market-place. Barely had he got there before twenty bags arrived at a run, some carried by a single native, but most of them by three or four. They were set down in orderly fashion under cover next to the bags that remained of the original twenty.

The Commissioner held up his hand for silence. "Thank you very much," said he; "the Court can now be opened once again, but you see that I do not yet require these bags, for I have still eight that remain over from those carried by the prisoners. We will now return the twenty bags to the store once more, and I will then start on the first case to be heard." A roar of laughter went up, for no one more appreciates being well scored off than does the African: the bags were returned, and cases started over again, to everyone's joy. Never since then had there been any trouble over getting odd jobs done on the station for a reward of the usual handful of salt.

The second season's cotton crop now stood about a foot high, and unless the natives were urged to do some weeding, the Commissioner knew that the plants stood every chance of being choked with weeds and grass. He had therefore promised Swewe to spend the week-end in his villages doing a tour of the native gardens. Lunch was quickly over, and Swewe, the Police, and those members of his staff who were to accompany him having been called, a start was made.

An hour's quick walking brought them to the edge of Swewe's first village. The Police and Houseboys were sent on to the camp, and the Commissioner and the old Chief, followed by the young man who acted as both his Prime Minister and confidential secretary, turned off into the scattered clearings in the bush in which the cotton had been planted. Much had been done in view of the Bwana's promised visit, much had still to be done, and the Commissioner praised here, upbraided there, and periodically threatened dire penalties when his eye fell on some particularly ill-kept cotton patch. On the whole, however, they had done extremely well, and the crop

promised to be considerably larger than that of the previous year. So at last to camp near Swewe's large hut, a "sundowner," a bath and dinner, with the prospect of plenty of exercise next day amongst the crops planted on the far side of the main village.

Two hours later the Commissioner was seated in a camp chair lazily watching the fire, over which his cook had prepared an excellent dinner, in spite of the primitive means at his disposal. He felt too lazy to read; he would see if he could get the old Chief to tell him a story. "Boy," he called, and when a black form had appeared from beside the fire, "go to Swewe's hut and ask him, if he is not doing anything in particular, to come and talk with the Bwana." The shadowy form faded away, and shortly afterwards the old man appeared in the dusk. Handing him a cigarette and a box of matches, the Commissioner murmured, "I would hear a story, Swewe, if you can think of one that you have not yet told me."

"Bwana," said Swewe, after a few minutes' thought, "you are young and I am old, yet you have much wisdom. All white men have greater wisdom than have the black, but that is because of the foolishness of our ancestors." He paused.

"Tell me the story," pleaded the Commissioner.

"Long, long ago, when the earth was young," began the old Chief, "all men were black. And God looked at the people and thought that they would look better if they were white, so he sent a messenger throughout the country, saying, 'On the day of the new moon be at the River Rukuru and bathe in the pool below the waterfall, and your bodies shall become white and comely.' Now all knew where the Rukuru waterfall was, though it was several days' journey across the mountains in a land that was uninhabited. Then some said, 'It is very far, but we must start soon,' and others said, 'In a week's time we will prepare food for the journey, and then we will go,' for the day appointed by God was still two weeks ahead.

"But certain men who were wise, chief amongst whom was Mlaka, commenced at once to prepare for the journey, and as soon as all was ready they started with their families, carrying sufficient food for the return journey and for the time that they might have to wait at the riverside for the new moon. When Mlaka and his people departed, many of those that were left behind started saying, 'They are foolish to start so soon; they will have to wait at the river,' yet they commenced to prepare their food. But the most foolish of all went on talking and wasting their time, and made no preparations for the journey, saying each day, 'To-morrow will do, to-morrow will do.'

"Then early in the morning, when there were but five days left before the new moon was due, those that had commenced to prepare food when Mlaka and his people left the village started on the journey, and those that remained said among themselves, 'Now we must really start,' and they got together all the food they could and left the village just before sunset, for they knew that only by hurrying could they reach the Rukuru on the day appointed, seeing that they would have to carry all their children save the older ones in order to travel swiftly.

"Now those that were wise and had started with Mlaka travelled slowly, and arrived at the Rukuru in the evening of the day before the new moon would rise, and camped below the pool at the foot of the falls. And they found that there was no water flowing over the falls, for it was the end of the dry season and there had been a drought. Next morning, at dawn, they went to the pool, and, having filled their gourds with water sufficient to last them for the return journey until they could reach the stream on the other side of the mountains, they bathed, and as they dipped their bodies beneath the water they became white all over. Gradually all were able to enter the water and bathe, though this took some time, as there was not much water in the pool. They dried themselves by running along the river bank, and sat down and waited to see who else would come. Then they looked at the pool and saw that there was very little water left in it, for besides the water with which they had filled their gourds much had been splashed on to the sand surrounding the pool and had sunk into the ground, and the drops that had remained on their bodies when they started to run to dry themselves had dropped on to the sand and so had been lost.

"And towards the evening those who had been lazy and had only started to prepare for the journey when Mlaka set out from the village arrived at the pool and rushed into the water. But there were many of them, so that none could bathe properly, but they splashed their bodies with what water they could scoop up with their hands, and those in the middle, where the water was deepest, became nearly white, though not as white as the followers of Mlaka, and those who could only get to the edge of the pool became brown. Then presently they climbed up the bank and came to where Mlaka and his people were sitting, and Mlaka said, 'Where are the others?' And they answered, 'They said they were coming, but they will be very late, for much of the grain they set out to be prepared for food for the journey they made into beer, so that they were still searching for food when we started.'

"At last, just as the sun was disappearing behind the mountains, a large number of people came rushing down the path carrying their children and stumbling in their haste—all the foolish ones who had delayed and delayed. Then they looked at the pool, which was now nothing but damp mud, and they rushed into the hollow and beat their hands upon the mud in their anger. And those who had arrived earlier saw to their astonishment that the palms of their hands had turned white where they had touched the mud, and the soles of their feet were also lighter in colour. So, Bwana, the Europeans are white, and have more wisdom than the Arabs and the Ahindi, and are wiser still than the natives. Have I not also heard the Bwana upbraid us because we say 'To-morrow will do, to-morrow will do'?"

Swewe paused and drew his blanket more closely round him. The Commissioner handed him another cigarette and a cup of tea from the tray that had just been brought, after first adding a large amount of sugar, as he knew the old man's tastes.

"Is not there also another way of telling the story?" asked the Commissioner, who dimly recollected having heard some similar tale on the coast. "The Arabs have another story, but the black man does not believe it," answered the old Chief. "Tell it me though," pleaded the other.

"Bwana," replied Swewe. "It is not a story that the black man should tell, for it was invented by the Arabs in order to scoff at us. Still, I do not believe it, neither wi ! you when I tell it to you. This is the Arabs' story.

"Long, long ago. all men were white—for. Bwana, the Arabs in their pride think that they are white, though the Bwana knows that they are not white as he is white, and from this one can tell that their story is lies, and that they are proud without reason. Long, long ago, God made all men white, and Shaitan, who is an evil spirit in whom the Arabs believe, looked with envy at those that God had made. And he said to himself, 'God made these men and women from clay, I also will make men from clay, and they shall be my servants.' Then Shaitan took clay and kneaded it and fashioned figures of men and women, and he built a huge kiln of wood round the figures, and set fire to the wood to bake them. But a high wind arose, and the sticks that had been built up round the figures were blown over and the fire burned very fiercely. So when the fire had burned away and the ashes were cool, Shaitan returned and uncovered the figures he had made, and behold the figures had fallen over when the whirlwind had struck the kiln. They had fallen on their faces, and where their noses and lips had struck the ground the

soft clay had flattened, and as the heat brought the figures to life they had raised themselves on their hands to a stooping position, but they had not been able to rise further because of the weight of the wood that covered them, and the fierceness of the fire had burned the figures black save for the palms of their hands and the soles of their feet, which had been protected as they had been touching the ground.

"Thus, Bwana, the Arabs say that the black man was made, and therefore are his nose and lips thick, and he is black save for his hands and feet. They have many stories, but they are mostly lies."

The old man rose to his feet. "Wangele, Bwana" (May you sleep well), he said, as he faded into the darkness.

A NOTE ON THE VEGETATIVE PROPAGATION OF COTTON PLANTS

BY

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Every worker on the cotton plant feels sooner or later the need of some rapid and easy method of propagating a single plant on a large scale. The need is felt most urgently when it is desired to effect a rapid multiplication of a pure line up to commercial proportions. It also arises in genetics where a large number of seeds is often required from a single plant in order to decide questions of doubtful segregation, ratios, etc. In the genetic studies now being carried on in Trinidad, several cases have been met with of plants which, though valuable from a genetic point of view, are subnormal in vigour, and which can best be kept alive by grafting on to a more vigorous stock.

Cotton may be budded, grafted, or grown from cuttings. Budding of cotton was first carried out in Hawaii (1909), where E. C. Smith was able to bud desirable types of Caravonica cotton on to stocks of poorer quality. The writer budded large numbers of cottons in St. Vincent (1917), and found that the West Indian perennial, or tree cotton (*G. purpurascens*), was an exceptionally good stock for Sea Island cotton.

Meade, in the United States, grafted American on to Indian cotton, and *vice versa*. The propagation of cotton from cuttings was successfully attempted in Hawaii (*loc. cit.*), and Longfield Smith, using this method in St. Croix in 1913, was also able to strike hardwood cuttings, though the percentage of successes was not high. The writer found in St. Croix that softwood cuttings in sand rooted in about 10 per cent. of cases. Experiments carried on in England in the greenhouse at the Shirley Institute in 1923-26 showed that in lower temperatures, *circa* 70° to 78° F., softwood cuttings would root without the slightest difficulty in a few days.

A simple method for the rapid propagation of herbaceous plants has recently been described by Blakeslee and Farnham, and is termed by them "bottle grafting." Mr. E. E. Cheesman successfully applied this method to cotton at my suggestion two years ago, and since then several hundred plants have been grafted.

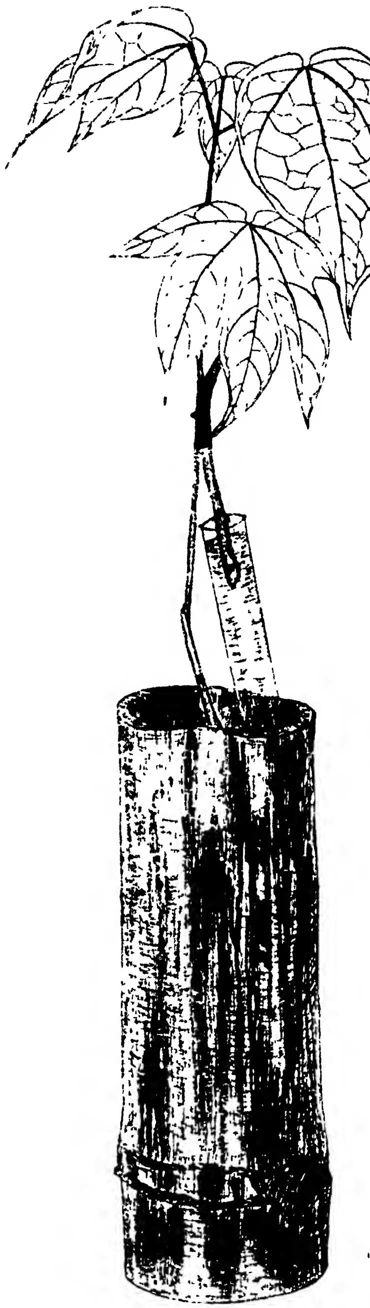

Diagram Showing Method of Bottle Grafting.

The method (see diagram) consists in utilizing seedlings of perennial cottons as stocks for the less vigorous Sea Island, Egyptian, and Upland types. The seeds are sown in bamboo pots and are grafted when a few inches high. A thin slice about 1 inch long is cut out of the side of the stock, and a similar slice out of the scion—a young shoot about 3 inches long. The two cut surfaces are fitted together and firmly wrapped with ordinary knitting wool. The cut end of the scion is placed in a tube containing water, and this serves to prevent the scion wilting until union has taken place. The head of the stock may be cut off in three weeks and the water removed.

The importance of this method to cotton-breeding work cannot be over-emphasized, and it is described here for the benefit of cotton workers in other countries. From a single plant during the growing season several hundred plants can be obtained in a few months, and any desirable strain propagated rapidly. Finally, it should be noted that by grafting a single plant may be made to produce enough lint for a spinning test.

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COTTON STATISTICS—CONSUMPTION AND STOCKS

BY

JOHN A. TODD, M.A., B.L.

We repeat herewith the statistics of consumption and stocks originally given in the issues of July, 1925, and January, 1926, respectively.

In the case of consumption we have carried the figures back a year further to include season 1911-12, because that was the year of the record pre-war consumption of American cotton which has not been exceeded even by 1925-26. But the pre-war consumption of "all kinds" has been beaten both in 1924-25 and 1925-26, and this suggests the desirability of an analysis of the consumption of various kinds of cotton in particular groups of countries. The following table gives the total consumption in the last two years of Table I. compared with the first two years, with the result expressed as percentages. To complete the figures for Asia (which covers India, Japan, and China), we have included a private estimate of the consumption in China for these two years, as the Federation had then no returns from China. China, however, was only consuming sundries at that time—*i.e.*, her own native cotton—so that any error in the estimate does not affect the statistics of consumption of the main crops:

POST-WAR *v.* PRE-WAR CONSUMPTION.

Two Seasons' Totals.	*U.K.*	*Continent.*	*U.S.A.*	*Asia.*	*World.*
All Kinds:					
1911–13	8,548	15,989	11,028	8,700	46,423
1924–26	6,257	13,573	13,946	13,144	49,399
Per cent.	*73*	*85*	*126*	*151*	*106*
American:					
1911–13	7,401	9,730	10,713	1,026	29,134
1924–26	4,437	8,203	13,496	1,784	28,409
Per cent.	*60*	*85*	*126*	*174*	*97*
Indian:					
1911–13	98	1,614	9	6,087	7,810
1924–26	351	2,171	61	8,438	11,093
Per cent.	*358*	*135*	*678*	*139*	*142*
Egyptian:					
1911–13	767	754	254	40	1,829
1924–26	822	684	265	91	1,892
Per cent.	*107*	*91*	*104*	*228*	*103*
Sundries:					
1911–13	281	3,892	52	1,547	7,650
1924–26	647	2,515	124	2,831	8,005
Per cent.	*229*	*65*	*238*	*183*	*105*

The consumption during the whole period, of American and of all kinds, is shown in the annexed double diagram.

From the summary it appears that the U.K. consumption of all kinds in the post-war years was only 73 per cent. of pre-war, while the Continent was 85 per cent., U.S.A. 126 per cent., and Asia 151 per cent. For American England's percentage is only 60 per cent., while the Continent and U.S.A. are again 85 per cent. and 126 per cent., but Asia has advanced to 174 per cent. In regard to Indian the total figures for the U.K. and U.S.A. are very small, but the increases in the Continent and Asia are noteworthy. The latter would have been still higher but for the Bombay strike in 1925. In the case of Egyptian the figures for Asia are negligible, but apart from them the U.K. percentage makes the best showing, which would have been still better but for the sharp fall in 1925-26. In Sundries, the U.K. again shows a big increase, but the figures for the Continent must be taken with a reservation as they mainly refer to the Russian consumption of native cotton.

In the Table of the American Carryover the U.S. Census Bureau have ceased to publish any complete figure; we have therefore substituted the records of a new statistical authority, Mr. Garside, of the Merchants' National Bank, Boston. He includes certain estimates of his own of the items which are known to be missing from the official figures, so that his total is generally larger than others.

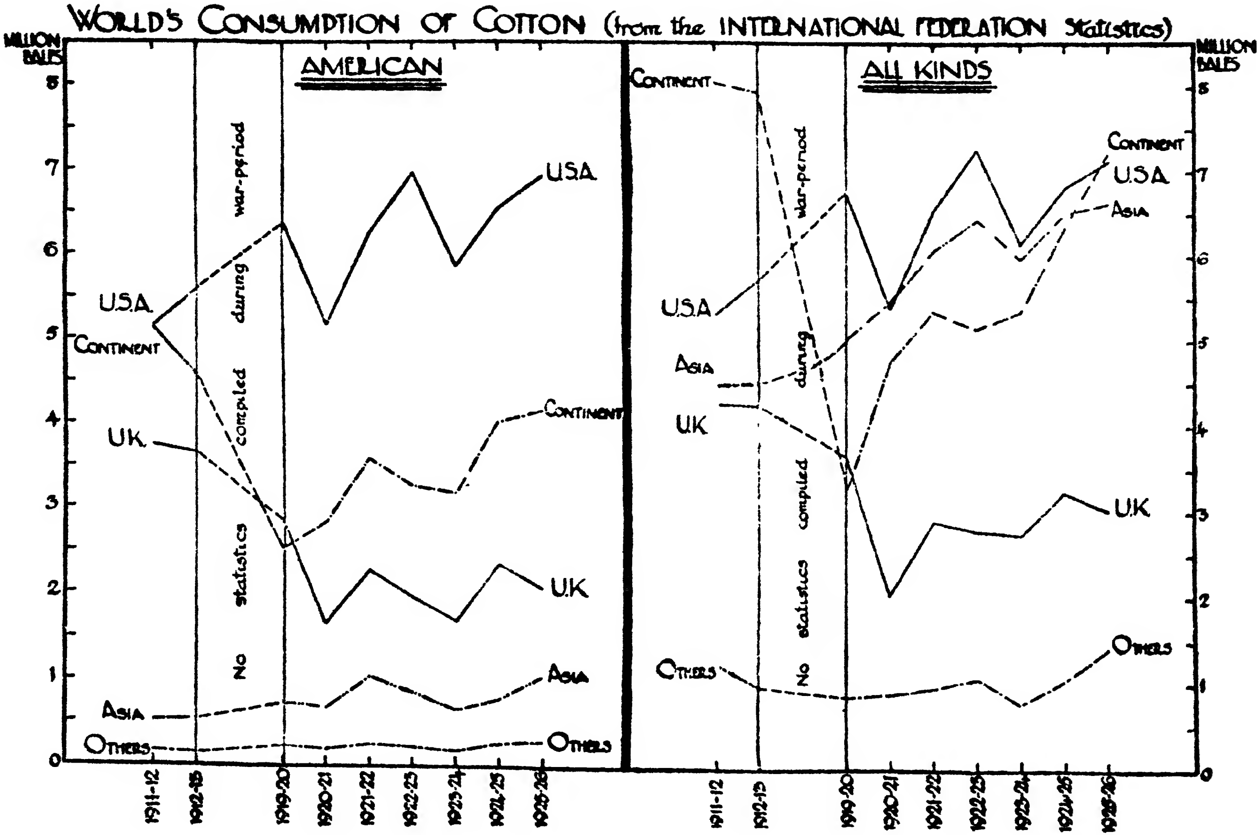
WORLD'S CONSUMPTION OF COTTON (from the INTERNATIONAL FEDERATION Statistics)
AMERICAN
ALL KINDS
MILLION BALES
No statistics compiled during war-period
U.S.A.
CONTINENT
U.K.
ASIA
OTHERS
1911-12
1912-13
1919-20
1920-21
1921-22
1922-23
1923-24
1924-25
1925-26

TABLE I.—WORLD'S CONSUMPTION OF ALL KINDS OF COTTON.

(From the Statistics of the International Federation.)

(Running Bales 000's Omitted.)

Variety.	*Season.*	*U.K.*	*Continent.**	*U.S.A.*	*Asia.*	*All Others.*	*Totals.*
American (including linters in U.S.A., as shown in brackets) ..	1911–12	3,734	5,137	5,160 (238)	507	140	14,678
	1912–13	3,667	4,593	5,553 (303)	519	124	14,456
	1919–20	2,980	2,538	6,345 (342)	709	209	12,781
	1920–21	1,678	2,802	5,193 (516)	684	192	10,549
	1921–22	2,275	3,593	6,252 (639)	1,031	216	13,367
	1922–23	1,919	3,293	6,968 (646)	859	201	13,240
	1923–24	1,695	3,199	5,890 (537)	661	172	11,617
	1924–25	2,344	4,009	6,576 (659)	772	228	13,929
	1925–26	2,093	4,194	6,920 (750)	1,012	261	14,480
	(first half)	1,156	2,216	3,426 (388)	431	133	7,362
	(second half)	937	1,978	3,494 (362)	581	128	7,118
Indian	1911–12	45	801	9	3,014	—	3,869
	1912–13	53	813	—	3,073	2	3,941
	1919–20	58	444	12	3,196	—	3,710
	1920–21	39	770	10	3,749	2	4,570
	1921–22	55	824	11	4,032	—	4,922
	1922–23	107	977	21	4,276	1	5,382
	1923–24	201	1,247	27	3,922	7	5,404
	1924–25	183	1,108	31	4,165	34	5,521
	1925–26	168	1,063	30	4,273	38	5,572
	(first half)	95	579	18	2,076	17	2,785
	(second half)	73	484	12	2,197	21	2,787
Egyptian ..	1911–12	374	374	120	23	2	893
	1912–13	393	380	134	17	12	936
	1919–20	441	173	216	24	—	854
	1920–21	237	136	106	22	13	514
	1921–22	336	208	151	38	9	742
	1922–23	393	272	175	40	10	890
	1923–24	469	354	149	39	16	1,027
	1924–25	431	350	128	49	13	971
	1925–26	391	334	137	42	17	921
	(first half)	191	161	66	18	8	444
	(second half)	200	173	71	24	9	477
Sundries ..	1911–12	120	1,764	20	749†	1,060	3,713
	1912–13	161	2,128	32	798†	818	3,937
	1919–20	141	116	160	1,077	614	2,108
	1920–21	70	1,039	67	981	672	2,829
	1921–22	199	716	114	980	708	2,717
	1922–23	351	616	98	1,262	850	3,177
	1923–24	353	529	76	1,351	576	2,885
	1924–25	277	896	66	1,523	785	3,547
	1925–26	370	1,619	58	1,308	1,103	4,458
	(first half)	204	704	29	671	527	2,135
	(second half)	166	915	29	637	576	2,323
All Kinds ..	1911–12	4,274	8,075	5,309	4,293†	1,202	23,153
	1912–13	4,274	7,914	5,719	4,407†	956	23,270
	1919–20	3,620	3,271	6,733	5,006	823	19,453
	1920–21	2,024	4,747	5,376	5,436	879	18,462
	1921–22	2,865	5,341	6,528	6,081	933	21,748
	1922–23	2,770	5,158	7,262	6,437	1,062	22,689
	1923–24	2,718	5,329	6,142	5,973	771	20,933
	1924–25	3,235	6,363	6,801	6,509	1,060	23,968
	1925–26	3,022	7,210	7,145	6,635	1,419	25,431
	(first half)	1,646	3,660	3,539	3,196	685	12,726
	(second half)	1,376	3,550	3,606	3,439	734	12,705

* No returns from Russia and Austria in 1919–20.

† Including China from a private estimate in 1911–12 and 1912–13.

TABLE II.—U.S. CONSUMPTION OF COTTON BY VARIETIES.

(000's of Running Bales: Foreign in Equivalent 500-lb. Bales.)

		Total.	*Upland.*	*Egyptian.*	*Other Foreign.*	*Sea Island.*	*American Egyptian.*	*Linters not Included.*
Monthly Averages.	1912–13	456·9	433·0	16·8	2·6	4·7	—	25·3
	1913–14	464·8	441·8	12·6	3·6	6·8	—	25·6
	1914–15	466·4	441·3	15·1	3·4	6·6	—	34·3
	1915–16	533·1	499·8	22·4	4·0	6·9	—	73·4
	1916–17	565·7	531·3	21·6	4·9	7·9	—	72·5
	1917–18	547·2	524·7	11·4	3·9	7·2	—	93·2
	1918–19	480·5	461·6	10·5	4·2	4·3	—	38·2
	1919–20	535·0	492·8	26·9	7·8	3·6	3·8	28·5
	1920–21	407·7	386·8	13·3	4·7	1·6	1·4	43·0
	1921–22	492·5	462·9	18·9	5·9	0·7	4·1	53·3
	1922–23	555·5	520·9	21·9	6·8	0·5	5·4	53·8
	1923–24	473·4	442·7	18·7	8·7	0·4	3·0	44·7
	1924–25	516·1	491·2	16·0	7·0	0·3	1·6	54·9
	1925–26*	537·6	513·1	17·0	6·3	0·1	1·0	62·5
Monthly Figures, 1923–24.	August ..	492·5	461·4	17·8	7·3	0·4	2·5	48·6
	September	485·7	459·0	15·7	8·1	0·3	2·5	50·6
	October ..	543·3	509·5	20·8	8·9	0·4	3·6	57·5
	November	532·7	501·7	19·9	8·2	0·5	2·5	48·8
	December	463·8	433·6	18·1	9·4	0·5	2·2	41·2
	January ..	578·5	541·8	23·4	9·8	0·5	3·0	40·6
	February..	508·7	473·3	23·0	8·4	0·5	2·5	41·7
	March ..	485·8	450·9	21·0	10·6	0·4	3·0	41·2
	April ..	478·6	443·0	21·2	9·5	0·6	4·3	42·1
	May ..	414·0	384·9	15·8	9·4	0·3	3·5	42·7
	June ..	350·0	325·8	13·9	7·1	0·2	3·0	40·0
	July ..	347·1	322·8	12·9	7·3	0·3	3·9	41·7
Monthly Figures, 1924–25.	August ..	357·4	335·5	11·7	6·7	0·4	2·9	44·9
	September	438·4	413·4	13·5	8·7	0·5	2·3	50·8
	October ..	534·2	508·5	14·0	9·2	0·4	2·3	57·5
	November	495·2	476·3	10·1	7·2	0·2	1·4	52·6
	December	533·8	509·1	16·5	6·6	0·3	1·3	47·7
	January ..	594·0	565·5	19·0	7·0	0·4	2·2	51·1
	February..	550·8	523·8	17·7	6·7	0·3	2·3	51·4
	March ..	583·4	557·1	17·7	6·8	0·3	1·5	58·8
	April ..	596·5	569·5	18·5	6·9	0·3	1·3	59·3
	May ..	531·6	506·9	17·1	6·1	0·3	1·2	61·3
	June ..	494·1	468·6	17·9	6·3	0·2	1·1	60·5
	July ..	483·9	458·7	17·9	6·2	0·3	0·8	63·0
*Monthly Figures, 1925–26.**	August ..	448·7	425·3	16·2	6·2	0·3	0·8	63·6
	September	483·3	456·6	17·9	7·9	0·2	0·7	70·0
	October ..	543·7	517·6	17·5	7·6	0·3	0·7	75·8
	November	543·1	523·5	12·6	5·9	0·2	0·8	66·0
	December	575·3	552·5	16·0	5·7	0·3	0·8	55·7
	January ..	583·2	556·9	18·3	6·8	0·3	0·9	56·5
	February..	567·2	541·3	19·2	5·6	0·2	0·9	54·0
	March ..	634·6	604·1	21·8	7·6	0·1	1·0	60·5
	April ..	575·8	550·5	18·2	5·7	0·1	1·3	62·0
	May ..	516·8	492·6	17·0	5·6	—	1·5	59·8
	June ..	518·5	495·4	15·1	6·6	—	1·4	65·1
	July ..	460·9	440·4	14·6	4·9	—	1·0	61·2
1926.*	August ..	500·7	477·0	17·2	5·1	—	1·4	67·8
	September	571·1	540·1	22·9	6·4	-	1·8	74·4
	October ..	569·0	540·0	20·9	6·3	—	1·8	76·0

* Subject to revision

TABLE III.—WORLD'S MONTHLY CARRYOVER OF *AMERICAN* COTTON.

(IN THOUSANDS OF RUNNING BALES, INCLUDING LINTERS IN U.S.A., ALSO SEA ISLAND AND AMERICAN EGYPTIAN, BUT NOT FOREIGN COTTON.)

End of	*Stock and Afloat.*		*U.S.A.*		*Monthly Totals.*	*Federation.*		*U.S.A.*				*L.C.A. Visible* Supply.*
	U.K.	*Continent.*	*Mill Stocks.*	*Public Warehouses.*		*Other Mill Stocks.*	*Half-Yearly Totals.*	*Elsewhere.*	*End of Season Totals.*	*Hester.*	*Garside.**	
1912, August ..	508	406	786	556	2,256	1,305	3,561	350	3,911	—	—	1,291
1913, February ..	1,384	1,270	1,898	2,251	6,803	1,459	8,262	—	—	—	—	4,052
August ..	423	282	699	492	1,896	1,011	2,907	375	3,282	—	—	1,018
1914, February ..	1,219	1,338	1,761	2,363	6,681	1.379	8,060	—	—	—	—	4,271
August ..	627	489	687	562	2,365	—	—	320	—	4,564	—	1,523
1915, January ..	1,076	1,142	1,581	4,746	8,545	—	—	—	—	—	—	5,565
July ..	1,238	753	1,491	1,839	5,321	—	—	850	—	7,701	—	3,260
1916, January ..	785	585	2,012	4,675	8,057	—	—	—	—	—	—	4,457
July ..	707	516	1,590	1,151	3,964	—	—	450	—	5,105	—	2,086
1917, January ..	941	740	2.324	3,837	7,842	—	—	—	—	—	—	4,283
July ..	237	332	1,521	1,069	3,159	—	—	440	—	4,305	—	1,531
1918, January ..	406	286	1,742	3,755	6,189	—	—	—	—	—	—	3,342
July ..	174	163	1,541	1,924	3,802	—	—	315	—	4,422	—	2,024
1919, January ..	524	389	1,896	4,722	7,531	—	—	—	—	—	—	3,700
July ..	806	486	1,519	2,402	5,213	—	—	1,150	—	6,844	—	3,307
1920, January ..	1,368	714	2,155	4,079	8,316	850	9,166	—	—	—	—	4,722
July ..	878	474	1,485	2,262	5,099	1,066	6,165	500	6,665	6,216	—	2,945
1921, January ..	840	758	1,391	5,880	8,869	1,050	9,919	—	—	—	—	4,731
July ..	839	805	1.222	3,874	6,740	1,137	7,877	1,960	9,837	9,364	9,944	4,094
1922, January ..	743	838	1,758	4,671	8,010	1,176	9,186	—	—	—	—	4,303
July ..	558	562	1,266	1,468	3,854	1,243	5,097	185	5,282	4,879	5.671	1,988
1923, January ..	605	682	2,054	3,458	6,799	885	7,684	—	—	—	—	3,450
July .	187	206	1,109	903	2,405	713	3,118	310	3.428	2.573	3,370	883
1924. January ..	742	555	1,673	3,001	5,971	815	6,786	—	—	—	—	3,196
July ..	228	310	739	695	1,972	691	2.663	220	2,883	2,319	2,754	934

* Excluding linters.

[*Continued overleaf.*

TABLE III.—WORLD'S MONTHLY CARRYOVER OF *AMERICAN* COTTON—*Continued.*

End of	*Stock and Afloat.*		*U.S.A.*		*Monthly Totals.*	*Federation.*	*Half-Yearly Totals.*	*U.S.A.*	*End of Season Totals.*	*Hester.*	*Garside.**	*L.C.A. Visible* Supply.*
	U.K.	*Continent.*	*Mill Stocks.*	*Public Warehouses.*		*Other Mill Stocks.*		*Elsewhere.*				
1924, July ..	228	310	739	695	1,972	691	2,663	220	2,883	2,319	2,754	934
August ..	181	192	561	827	1,761	—	—	—	—	—	—	817
September .	290	386	521	2,083	3,280	—	—	—	—	—	—	1,714
October ..	432	604	755	4,250	6,041	—	—	—	—	—	—	3,385
November ..	634	810	1,100	4,932	7,476	—	—	—	—	—	—	4,465
December ..	809	906	1,389	4,651	7,755	—	—	—	—	—	—	4,914
1925, January ..	1,016	945	1,509	3,895	7,365	1,004	8,369	—	—	—	—	4,746
February ..	1,048	910	1,611	3,121	6,690	—	—	—	—	—	—	4,373
March ..	984	934	1,699	2,054	5,671	—	—	—	—	—	—	3,794
April ..	891	836	1,583	1,676	4,986	—	—	—	—	—	—	2,945
May ..	722	654	1,407	1,150	3,933	—	—	—	—	—	—	2,255
June ..	577	548	1,188	763	3,076	—	—	—	—	—	—	1,730
July ..	401	373	916	516	2,206	1,046	3,252	270	3,522	2,991	3,592	1,140
August ..	264	292	707	1,040	2,303	—	—	—	—	—	—	1,117
September ..	273	471	888	3,113	4,745	—	—	—	—	—	—	2,365
October ..	458	822	1,246	4,509	7,035	—	—	—	—	—	—	4,157
November ..	670	990	1,515	5,225	8,400	—	—	—	—	—	—	4,934
December ..	804	1,052	1,801	5,637	9,294	—	—	—	—	—	—	5,480
1926, January ..	802	905	1,901	5,211	8,819	1,121	9,940	—	—	—	—	5,268
February ..	779	857	1,932	4,785	8,353	—	—	—	—	—	—	4,946
March ..	736	791	1,865	4,204	7,596	—	—	—	—	—	—	4,414
April ..	706	682	1,729	3,571	6,688	—	—	—	—	—	—	3,866
May ..	702	604	1,527	3,003	5,836	—	—	—	—	—	—	3,465
June ..	644	531	1,335	2,427	4,937	—	—	—	—	—	—	2,928
July ..	579	406	1,155	1,948	4,088	959	5,047	510*	5,557	5,362	5,750	2,312
August ..	512	354	963	1,722	3,551	—	—	—	—	—	—	1,982
September ..	554	620	965	3,307	5,446	—	—	—	—	—	—	2,683
October ..	727	824	1,258	5,495	8,304	—	—	—	—	—	—	5,095

* Excluding linters.

TABLE IV.—WORLD'S CARRYOVER OF *EGYPTIAN* COTTON.

(KANTARS 000's BALES CONVERTED AT 7·5 KANTARS (EUROPE) AND 5·0 KANTARS U.S.A.)

End of	*Stock and Afloat.*		*U.S.A.*		*Alexandria.*	*Monthly Total.*	*Federation.*	*Half-Yearly Total.*
	U.K.	*Continent.*	*Mills.*	*Warehouses.*			*Half-Yearly.*	
1912, August ..	302	30	424*	—	350	1,106	1,387	2,493
1913, February ..	652	122	418*	—	2,176	3,368	2,070	5,438
August ..	418	31	354	13	491	1,307	1,485	2,792
1914, February ..	765	98	185	24	2,606	3,678	2,130	5,808
August ..	467	10	259	26	766	1,528	—	
1915, January ..	921	127	227	43	2,328	3,646	—	
July ..	758	71	484	126	1,074	2,513	—	—
1916, January ..	1,347	93	336	91	1,377	3,244	—	—
July ..	351	50	617	296	104	1,418	—	—
1917, January ..	1,270	98	357	146	1,225	3,096	—	—
July ..	431	27	376	213	589	1,636	—	—
1918, January ..	1,001	25	136	87	2,651	3,900	—	
July ..	541	185	180	157	1,727	2,790	—	
1919, January ..	607	80	207	86	2,896	3,876	—	—
July ..	526	170	185	79	2,060	3,020		—
1920, January ..	1,291	282	277	165	1,532	3,547	1,852	3,399
July ..	466	79	587	514	601	2,247	1,365	3,612
1921, January ..	446	151	415	336	1,606	2,954	1,035	3,989
July ..	688	158	345	296	1,992	3,479	1,005	4,484
1922, January ..	1,043	204	317	322	2,511	4,397	1,087	5,484
July ..	835	148	314	267	1,669	3,233	1,252	4,485
1923, January ..	1,272	272	315	285	2,380	4,524	1,177	5,701
July ..	859	129	447	265	1,096	2,796	1,200	3,996
1924, January ..	1,155	322	336	129	1,841	3,783	1,320	5,103
July ..	517	128	259	63	384	1,351	1,155	2,506
August ..	450	68	224	49	260	1,051	—	—
September ..	435	120	182	35	628	1,400		—
October ..	510	217	138	32	1,453	2,350	—	—
November ..	668	135	125	35	1,901	2,864	—	—
December ..	840	285	169	37	1,964	3,295	—	—
1925, January ..	645	195	265	54	1,892	3,051	1,215	4,266
February ..	758	277	317	56	1,614	3,022	—	—
March ..	668	127	350	107	1,368	2,620	—	—
April ..	653	135	333	129	1,091	2,341	—	—
May ..	630	120	318	102	814	1,984	—	—
June ..	533	97	293	77	647	1,647	—	—
July ..	443	75	253	57	411	1,239	1,103	2,342
August ..	383	60	209	39	393	1,084	—	—
September ..	345	98	180	42	660	1,325	—	—
October ..	473	187	130	30	1,576	2,396	—	—
November ..	638	210	100	31	1,808	2,787	—	—
December ..	698	127	137	47	2,251	3,260	—	—
1926, January ..	668	217	228	106	2,267	3,486	1,275	4,761
February ..	743	157	250	122	2,316	3,588	—	—
March ..	802	173	329	138	2,137	3,579	—	—
April ..	893	202	334	135	2,073	3,637	—	—
May ..	1,043	195	330	149	1,903	3,620	—	—
June ..	1,065	150	321	150	1,843	3,529	—	—
July ..	930	120	322	143	1,544	3,059	1,185	4,244
August ..	930	75	305	88	1,101	2,499	—	—
September ..	848	82	263	59	1,261	2,513	—	—
October ..	758	202	202	37	1,859	3,058	—	—

* ... not given

COTTON RESEARCH LABORATORY,
LYALLPUR, PUNJAB.
August 26, 1926.

To the Editor,
"EMPIRE COTTON GROWING REVIEW,"
MILLBANK HOUSE, MILLBANK,
LONDON, S.W. 1.

DEAR SIR,

With reference to Messrs. Engledow and Yule's paper in Vol. III., Parts 2 and 3 of the REVIEW, I note that they "venture the suggestion" that a lay-out in strip would probably be most suitable for cotton variety experiments. The experiments we did in Egypt* show this definitely.

At the same time we showed that the best size of plot was actually $\frac{1}{8}$ acre. We did not find that there was so great a difference between $\frac{1}{8}$, $\frac{1}{10}$, and $\frac{1}{20}$ acre beds as to make the size, within these limits, more than a matter of convenience and land available. We recommended that there should be at least ten repetitions in each variety, and that the experiment should be repeated over at least three years.

These remarks apply to field experiments which are not under immediate control in an experimental area. In an experimental area close to the laboratory Balls' flowering and bolling curves taken on plants suitably scattered provide an accurate means of comparison.

Yours faithfully,

TREVOR TROUGHT,
Cotton Research Botanist.

* "An Account of Experiments carried out to determine the Experimental Error of Field Trials with Cotton in Egypt," by M. A. Bailey and T. Trought. Bulletin No. 63, Egyptian Ministry of Agriculture.

NOTES ON CURRENT LITERATURE

COTTON IN INDIA.

1. We have recently received a copy of the "Report on the Work of the Indian Trade Commissioner during 1924-5 and 1925-6," by H. A. F. Lindsay, C.I.E., C.B.E. Statistics of cotton production and exports for the last seven years are given on p. 43.

2. Cotton Cultivation in India. (*Text. Mercury*, 1926, **75**. Abstr. in *Summ. Curr. Lit.*, vi., **16,** 1926, E. 93.) Deals with the importance of the proper use of fertilizers.

3. The Agricultural Development of the Canal Tracts of the Bombay Deccan. By T. F. Main. (Abstr. from the *Agr. Jnl. of India*, xxi., pt. 5, 1926, p. 343.) "The most promising alternative money crops of the Canal Tracts of the Bombay Deccan are cotton and groundnuts. Certain other crops, such as potatoes and turmeric, may also find a place. . . . Groundnuts have already become well established on the Nira Left Canal, where the area is now 6,000 acres, but perhaps cotton will ultimately prove to be the mainstay of the irrigated Deccan. . . . Everyone is familiar with the excellent financial results obtained with this crop, but at present there appears to be no great liking for it on the Deccan canals. On the other hand, there has been a great development of cotton-growing on wells in the Sholapur District, which is not far from these canals, where yields up to 1,500 lbs. of seed cotton per acre have been common on manured land."

COTTON IN THE EMPIRE (EXCLUDING INDIA).

4. The following Reports have recently been received:

Barbados. "Report of the Department of Agriculture, 1925-1926."
China. "Report on the Commercial, Industrial, and Economic Situation to June, 1926."
Cyprus. "Annual Report of the Department of Agriculture, 1925."
India. "Report on the Work of the Indian Trade Commissioner during 1924-5 and 1925-6." "Annual Report of the Indian Merchants' Chamber, 1925."
Kenya Colony. "Annual Report of Department of Agriculture, 1925."
Nyasaland. "Annual Report of the Department of Agriculture, 1925."
Sierra Leone. "Report on the Survey of the Soils of the Colony and Protectorate of Sierra Leone, 1925." "Annual Report of the Lands and Forests Department, 1925." "Trade Report, 1925."
Sudan. "Report on the Finances, Administration and Conditions of the Sudan in 1925." "Annual Report of the Central Econ. Board, 1925-1926."
Uganda. "Annual Report of the Department of Agriculture, 1925."

5. EUROPE: Cyprus. From the *Ann. Rpt. of the Director of Agr.*, 1925, we learn that during the year under review the cotton crop was much affected by the dry spring. The results on the experimental plot tend to show that Durango, Triumph, and Zagora are the varieties best suited to the Island. Bollworm did much damage. The yield of cotton was slightly less than in 1924.

6. ASIA: CEYLON. *Cotton Growing Progress.* (Abstr. from *Text. Mercury,* October 9, 1926, p. 466.) From a report of Mr. Harbord, Agricultural Officer of the Southern Division of Ceylon, we learn that from the land given out to natives for the experimental cultivation of cotton in the Hambantota district and in Embilipitiya, Sabaragamuwa Province, a first pick of 2,500 cwt. of first quality cotton has been secured, and it is expected that the second pick will realize a further 1,000 cwt.

Hambantota has been well led by the officers of the Agricultural Department in the matter of technical knowledge in the growing of cotton, with the result that troubles encountered from pests have been more or less negligible.

It is said that much of the area in the south suitable for cotton has been fairly tested already through the aid of the small holder, but on the recommendations of Mr. G. R. Hilson, Cotton Specialist of the Government of Madras, the Advisory Committee appointed by Sir Hugh Clifford, the Governor of Ceylon, has urged ampler tests by the small holder by continuing to grant cotton chenas, in addition to cereal chenas, for a further period of five years before launching out on a big scale.

As an encouragement to continued rotation cultivation, a cultivator who has sown cotton on a one-acre chena for a second season will now get an additional two acres adjoining his first clearing. Should he continue to carry on regular rotation cotton cultivation for five years on all the four acres of land given to him under the three chena permits, including the cereal acre, he would then have the right to claim the land to be settled on him. In case the original permit holder dies, his near kith and kin would enjoy the same rights, provided they have carried out the requirements of the whole contract. In all cases cereal food crops and cotton are to form the main rotations.

The Department of Agriculture has been asked to carry on further cotton-growing investigation work at the Cotton Experimental Station at Ambalantota. Two other cotton-growing centres will be established in the Hambantota district, each of twenty-five acres, so that the Department of Agriculture, after a five years' rotation of chiefly food crops and cotton, would be able to afford a critical analysis of value to the larger capitalist.

With a view to encouraging cotton cultivation in the northern province, it is recommended that the Department of Agriculture should be helped to establish a twenty-five acre Experimental Station at Vavuniya.

An anti-tropical diseases campaign has been started with a view to fighting malaria and other tropical diseases in the whole island, including the cotton-growing territories.

7. *Cotton cultivation at Embilipitiya, Ceylon.* (Abstr. from *Trop. Agriculturist,* lxvii., 3, 1926, p. 161.) Cotton cultivation was tried at Embilipitiya by the Department of Agriculture for the first time in 1923. Cambodia was planted on a small plot of one and a half acres, and gave a yield of 542 lbs. of seed cotton to the acre. In 1925 this yield was increased to 902 lbs. an acre. Encouraged by the success of these experiments, village cultivators have undertaken cotton cultivation and applied for chenas, but only six were given one and a half acres each for growing cotton. Their endeavours may be said to have been successful, as the nine acres under cotton yielded 30 cwt.

8. IRAQ. *Cotton in Iraq.* (Abstr. from the *Times of India,* 14/x/26.) Considerable efforts are being made by the responsible authorities to encourage the planting of a larger area of cotton this season. A recent meeting held at Hillah with this end in view was attended by a large and enthusiastic gathering, which included the sheikhs of the most important tribes, several leading English officials of the irrigation directorate, and Mr. Austin Eastwood, the Iraq manager

of the British Cotton Association. At the meeting, which lasted three hours, the claims of cotton-growing as a money-making proposition were urged to the attendant sheikhs and local visitors, who all received an invitation to journey to Baghdad and inspect the recently enlarged ginnery of the British Cotton Growing Association.

9. AFRICA: CAMEROONS. *Cotton Cultivation in the Cameroons.* By — Wolff. (*Bot. Abs.*, 1925, **14**, 1277. Abstr. in *J. Text. Inst.*, vol. xvii., **9**, 1926, A. 250.)

10. EAST AFRICA. *East African Cotton Growing.* (Abstr. from *East Afr.*, vol. 3, no. 110, 1926, p. 156.) A letter from Mr. W. A. Ball, Managing Director of the African-Grown Cotton Co., urges the importance of cheapening and improving transport. He quotes the rates in various places as follows, for ginning, pressing, and transport (including insurance) of seed cotton from the place of growth to the ocean port (calculated from average interior point in country of growth):

U.S.A. (New Orleans)	0·63d. per lb.
East Africa	2·90d. ,, ,, (including export tax)
West Africa	1·90d. ,, ,,
South Africa	Probably not above West African cost.

Mr. Ball makes the following suggestions for improving the position:

(1) Reduction of ginning and pressing charges.

(2) Reduction of freight rates, both rail and ocean, for the coming year at all events.

(3) Cancellation of export tax for one year.

(4) Government inquiry to ascertain why the banks are unable to supply the necessary financial facilities.

(5) Avoidance of the mixture of different qualities of cotton in bales.

(6) Care in the process of ginning, especially when saw-gins are used.

(7) Protection and careful handling of bales in transit, particularly at transhipment points.

(8) Ginners to be made responsible, under penalties, for the supply to the buyer of representative samples of every bale pressed.

11. KENYA COLONY. From the *Ann. Rpt. of the Dpt. of Agr.*, 1925, recently received, we quote the following with reference to cotton: "The issue of seed for this crop is controlled, all seed being approved by the Department. A large quantity of new seed was secured from Uganda towards the close of the year. The 1924 plantings, harvested in 1925, gave a production of 2,300 bales for the Colony, and practically all native grown. The price of 'A' quality seed cotton varied from twenty-three to eighteen cents per pound, getting lower towards the end of the season.

"The area planted in 1925 showed a decrease, as those 'shambas' planted by natives in unsuitable places have been eliminated. Planting was arranged for February and March for the Gulf Shore, but owing to drought the seed did not go into the ground until May, and as the season was a very poor one, a failure is to be recorded all round the Gulf. In the Sio-Samia area and North Kavirondo planting takes place much later, and here again the crops suffered from the drought of August and September, so that a reduced crop is to be expected. Buying commenced towards the end of December, and the low price paid, which, however, was quite in consonance with Liverpool market prices, caused natives much dissatisfaction, to the extent that many will probably refrain from planting in 1926. In the Taveta area, where there is a small ginnery, a very small crop was produced. The natives here appear to be too prosperous

to bother about cotton, and therefore a crop which they could grow to perfection is being ignored. As irrigation is available for these people, it is a matter for regret that they are not more industrious and progressive. At Malindi the crop was affected by drought, only 150,000 lbs. of seed cotton having been brought in at the close of the year. This quantity is sufficient to keep the ginnery working full time for 30 days."

12. NIGERIA. *Cotton in Nigeria.* (Abstr. from the Hon. W. G. A. Ormsby-Gore's Report on his visit to West Africa in 1926, p. 122.) Cotton is fast becoming one of the chief exports of Nigeria. During the last twenty years cultivation has progressed steadily in the Northern Provinces. The average export for the three years 1903-5 was 217 bales. In the five years 1921-25 it was 16,085 bales from the Northern Provinces. More interesting, however, and more indicative of rapid progress, is the fact that American cotton seed was first distributed in 1916, and that the export of this product (Allen Long Staple Variety) was 36,000 bales in the season of 1925-26. Cotton ginning is at present entirely in the hands of the British Cotton Growing Association. There is no question of any monopoly, but the Association offers full facilities to other buyers, and therefore there is little incentive to competition in ginning. There are at present only five ginneries in the Northern Provinces and two in the Southern. A few further additional plants are being set up, though there appears to be some risk that ginning facilities will not be adequate to deal expeditiously with the increasing cotton crop.

In Nigeria, the dividing-line between the districts where cotton will and will not grow passes through the Provinces of Oyo and Ilorin. South of this line cotton pests seriously hamper production, but northward of it high yields can be anticipated if cotton cultivation can be extended along the belt which runs for about 100 miles along the dividing-line. In this region cotton is grown already as a catch crop, and there is also an established industry for local weaving. If the efforts of the Agricultural Department are successful in producing a type of native cotton which will be resistant to disease and of satisfactory quality as regards colour and length of staple, there seems good reason to hope for an immense increase in the output of cotton from these areas.

In the Northern Provinces, the most fruitful area in which the cultivation of cotton can be extended appears to be north and north-west from Zaria, towards Sokoto. A railway is under construction in this direction north-west from Zaria as far as Gusau, where a large new ginnery is in process of erection, and Mr. Ormsby-Gore has recommended its extension further to Tallata Mafara. It is proposed to move the existing ginnery at Gusau further afield, so as to extend from the railway the centres at which cotton can be ginned and baled for transport.

13. NYASALAND. *Cotton Cultivation.* (Abstr. from the *Ann. Rpt. of the Dpt. of Agr.*, 1925.) During the year under review there was a reduction of the area under European cotton cultivation. The first crop was seriously devastated by bollworm, but fortunately the second crop was abnormally good. The yield per acre for the whole country proved to be 64·5 lbs. as compared with 66·1 lbs. in 1924.

The results of cotton-growing by natives were very satisfactory, and although the native crop for 1924 was the largest on record, it was more than doubled by that of 1925. The following prices were paid by the British Cotton Growing Association for native-grown cotton:

No. 1 grade	2d. to 2½d. per lb.
,, 2 ,, ...	1½d. to 1¾d. ,, ,,
,, 3 ,, ...	1d. per lb.

The total sum distributed to the natives in payment for their cotton amounted to £59,637, as compared with £24,500 in 1924.

The Report states that Nyasaland continues to be under a debt of gratitude to the Empire Cotton Growing Corporation for their generous assistance to the cotton industry. An outline is given of the various experiments being carried out by officers appointed by the Corporation, and a warm tribute is paid to the valuable work accomplished by Mr. Sampson during the time he was in charge of the Corporation's activities in the Protectorate.

14. In Mr. C. Ponsonby's article on *Cotton in Nyasaland*, p. 322 of pt. 4 of vol. iii., various **errata** occur in the figures of two tables, which have been corrected in the reprint. The revised figures for the tables are given below:

Page 324:

Year.	*Imports* (*Value.*) £	*Exports* (*Value.*) £
1901	116,751	21,739
1908 (opening Shire Highlands Railway)	124,687	81,791
1910 (two years after)	193,490	148,176
1915 (opening Central Africa Railway)	248,810	212,910
1916 (one year after)	402,026	302,066
1920	507,573	670,072
1924	548,156	583,555
1925	591,654	564,926

Page 326:

Year.	*Cotton Acreage.*	*Exports* (*Lbs.*)
1902	580	692
1908	8,975	756,120
1912	23,755	3,345,283
1915	29,578	3,240,231
1918	18,141	2,630,026
1921	26,529	1,475,232
1923	20,948	2,182,537
1924	26,120	2,229,317
1925	17,541	2,291,875

15. Rhodesia (Northern). *Cotton Cultivation.* (Extract from the *Ann. Rpt. of Dpt. of Agr.*, 1925.) "The experience gained in the growing of cotton in Northern Rhodesia has proved that the time has not yet arrived for large acreages to be planted. It is quite possible that in a season of light rains the resultant crop would be good, but it is not sound business to gamble on such conditions. It is obvious that a variety of plant which is highly resistant to jassid is one of the essentials, and means for dealing with pests such as bollworm are necessary. It is also possible that the variety of seed which is eventually successful will have to be selected, and acclimatized, in the Territory. Experiments with this object in view are being carried out, and every advantage is being taken of the research and experimental work which is proceeding along these lines in other colonies. In the meantime, the proper policy in connection with cotton-growing would appear to be the planting of limited acreages which can easily be worked, and which will not cause too great an outlay if the season should prove to be adverse. Northern Rhodesia is faced with the problems which confronted other countries when new crops were introduced, and it is hoped that cotton-growing may eventually be established on a sound basis."

The Report states that there are now two ginneries in the Territory, one at Pemba and a larger one at Mazabuka. Certain new machinery has been ordered for the latter ginnery, in order to bring the plant up to date.

16. Rhodesia (Southern). *Cotton Seed for Planting.* By G. S. Cameron. (Abstr. from *Rhod. Agr. Jnl.*, xxiii., **10**, 1926, p. 917.) In these notes the author deprecates the importation of any variety of cotton seed in large quantities until such variety has been proved suitable for Southern Rhodesia in a regularly conducted series of trials. There is also a grave risk, in importing seed in bulk from other cotton-growing countries, of the possible introduction of additional cotton pests. Mr. Cameron states that the question of the supply of good home-grown seed has been taken in hand, and it is considered that there will be enough to meet the demand. A list of the names and addresses of farmers who will have approved seed for sale is appended.

17. Sierra Leone. *Cotton Cultivation.* (Abstr. from *Ann. Rpt. of the Lands and Forests Dept.*, 1925.) From this Report, recently received, we learn that a further attempt has been made to establish the cultivation of Allen's Long Staple cotton, with successful results in some districts. The cultivation of Quande cotton—the local variety—has also been encouraged.

18. *The Effect of Lime on Soil.* By F. J. Martin. (Abstr. from the *Rpt. on the Survey of the Soils of the Colony and Protectorate of Sierra Leone*, 1926, p. 13.) An interesting experiment, showing the effect lime may have on certain soils, was carried out at Njala. Land bearing high bush was cleared and divided into plots, which were then treated in the following manner:

(*a*) Lime applied at the rate of 2 tons per acre.
(*b*) No lime applied.

Cotton was sown on these plots, and the yields of the limed and unlimed plots are given in the following table:

	pH.	*Lime Requirement.*	*Yield (Lb. per Acre.)*
Control plots—untreated	4·4	·41	251
Plots receiving lime only	5·4	·25	352

The marked increase in yield of cotton on the limed plots is very significant, while the beneficial effect of this form of treatment is equally well shown by the pH values and lime requirement figures.

19. South Africa. *Cotton Growing.* (Abstr. from the *Natal Advertiser*, October 8, 1926.) It is stated that cotton-growers in the Union are becoming increasingly progressive, and are not only making full use of the experience gained in the past, but are in a better position to deal with their crops. In addition, great interest is being taken in the quality of seed to be planted, and there can be no doubt that these factors will tend to increase yields and better the quality of South African cotton.

The bollworm is the worst cotton pest encountered in South Africa, but through the interest and activities of the Department of Agriculture and the Empire Cotton Growing Corporation, this handicap is not viewed too seriously, and faith in the future of cotton cultivation is expressed in all quarters.

20. *The Present State of the Cotton Industry.* (Abstr. from the *Sun and Agr. Jnl. of South Africa*, August, 1926, p. 763.) In an interview given to the *Sun and Agricultural Journal of South Africa*, Mr. Milligan states that it is now fairly obvious that cotton in South Africa must form a crop in a rotation rather than that it should be grown, year after year, on the same soil. The latter practice, in addition to being risky, tends to reduction in yield.

The two distinct tracts in which cotton is at present grown—viz., the Middle Veld and the Low Veld—differ considerably, and will probably require different strains of cotton. In the Low Veld area the jassid forms a limiting factor in

cotton production, but as a result of the efforts of Mr. Parnell, of the Empire Cotton Growing Corporation, several strains of cotton have been isolated which have strong resistant properties as regards this pest, and it is hoped that in a few years' time sufficient seed from these strains will be available for Low Veld areas. Meanwhile, the officers of the Government Cotton Station at Rustenburg have been working on the improvement of strains suitable for Middle Veld conditions, where jassid is not a factor to be considered, and are now issuing seed which is a vast improvement on anything that has hitherto been available for planting. In addition to these experiments, investigations into the habits of bollworms have been carried out by the Division of Entomology, and some useful information has been obtained.

21. *Cotton Growing To-day in the Union of South Africa.* By Capt. S. L. P. Barker. (*S. Afr. Cott. Growers' Jour.*, vol. iii., no. 2, 1926, p. 9, and subsequent number.)

22. *Extending South Africa's Cotton Belt. Can the Cape Province produce Suitable Cotton?* (Abstr. from *S. Afr. Cott. Growers' Jour.*, vol. iii., no. 2, 1926, p. 23.) At the recent Cape Agricultural Congress held at Port Elizabeth it was resolved that Congress urge the Agricultural Department to make a thorough enquiry into the possibilities of the cultivation of cotton in suitable areas throughout the Cape Province, and to conduct a series of experiments in as many districts as possible, particularly with regard to ascertaining the most suitable type of cotton for each district, as well as methods to combat cotton diseases and pests.

23. *Cotton Enterprise in Zululand.* (Abstr. from *Afr. Land and Home Jnl.*, ii., **4**, 1926, p. 19.) A description of the ginnery of the Zululand Co-operative Cotton Association at Empangeni, which was opened in July last by Mr. S. Milligan of the Empire Cotton Growing Corporation.

24. SUDAN. The Director's *Annual Report* for 1925-26, *Central Econ. Board*, Sudan Government, contains interesting accounts of cotton cultivation in the various provinces (pp. 27-32.) Rain-grown cotton is also dealt with on pp. 32-34.

The Report states that Government ginning factories have been provided at Atbara and Makwar—the latter mainly for rain-grown cotton. Factories for this cotton are also being put up by the Government at Talodi and Kadugli in the Nuba Mountains Province, and at Torit and Yei in Mongalla Province. There is also a Government ginning factory at Port Sudan, where new cotton storage sheds have lately been completed.

25. *Cotton Cultivation.* (Abstr. from the *Rpt. on the Finance, Administration, and Condition of the Sudan*, 1925, pp. 19 and 22.) Progress in the development of rain-grown cotton in the Southern Provinces is satisfactory, but must of necessity be slow owing to the backward nature of the people and the difficulties of transport with a small population scattered over a large area.

The exports of cotton during the year under review were less than in 1924, though the value was rather more.

26. UGANDA. *New Cotton Tax.* The Secretary of State for the Colonies has approved the recommendation of the Governor of Uganda that as from January 1, 1927, the present fixed rate of cotton tax should be replaced by a tax on a sliding scale, based on the closing price of "June Futures, American Middling" on the last business day in December on the Liverpool Cotton Exchange.

The scale which it is proposed to introduce is as follows: Closing price on Liverpool Cotton Exchange of June American "Middling" Futures on last business day in December — pence per lb.

		Excise Duty.
	6·00d. per lb. or below	No excise duty.
Between	6·01d. " " and 7d.	2 cents per lb.
"	7·01d. " " " 8d.	3 " " "
"	8·01d. " " " 9d.	4 " " "
"	9·01d. " " " 10d.	5 " " "
"	10·01d. " " " 13d.	6 " " "
"	13·01d. " " " 14d.	7 " " "
"	14·01d. " " " 15d.	8 " " "
Over	15d. per lb.	9 " " "

27. *Uganda Cotton.* (Abstr. from *East Afr.*, vol. iii., **108**, 1926, p. 91.) When Sir William Gowers, Governor of Uganda, was entertained at Manchester by the British Cotton Growing Association, Lord Stanley, who presided, said that their guest had done much to assist in the development of cotton-growing in the Empire.

In his speech, Sir William Gowers said that cotton was really the life-blood of Uganda. More than 94 per cent. of the exports of the country in 1925 were cotton; coffee only accounted for 2½ per cent. That was a very precarious position, which made it vitally important for Uganda to produce a quality of cotton which would always command a ready market in Lancashire and a good premium. The Government was helping the industry by the introduction of new seed, which would give better yield and better staple. They were also assisting by the establishment of a research laboratory at Kampala, and by the extension of railway facilities.

28. In the *Ann. Rpt. of Dpt. of Agr.*, 1925, the report of the Cotton Botanist (p. 16) describes, *inter alia*, the work of selection that is being carried on at the Serere Experimental Station. The report of the Mycologist (p. 23) deals especially with seedling diseases, and that of the Entomologist (p. 25) with cotton stainers, bollworms, and insects attacking the roots of cotton. Cotton-growing in the Lango and Teso Districts is dealt with in the report of the Senior Agricultural Officer on p. 29.

29. *Cotton Prospects.* (Abstr. from *East Afr.*, vol. iii., **105**, 1926, p. 23.) The Kabaka of Uganda, speaking at the official celebration of his thirtieth birthday, stated, in reference to native cotton-growing, that the sudden fall in prices early this year had seriously affected this season's output of cotton. He was confident, however, that with the assistance and advice of the Agricultural Department, his chiefs would do all they could to promote the cultivation of cotton in their respective administrations, and he had every reason to hope that next season's output would be a great improvement on this year, and that the prosperity of the Baganda in general would be assured.

30. *Cotton Prospects.* The latest report received from the Department of Agriculture states that heavy rains have been experienced in most of the districts, but the condition of the cotton crop is generally satisfactory. Approximately 585,000 acres have been planted to cotton for the 1926-27 season.

31. *Cotton Prospects.* (Abstr. from *East Afr.*, vol. ii., **100**, 1926, p. 1047.) An East African correspondent writes the following: "What will be the attitude of the natives to next season's planting? Will the comparatively low prices realized during the past season, and the decrease in the output, lead to any considerable reaction? Reports naturally tend to be somewhat conflicting, but judging by

what I have been told by many growers, and those in the closest touch with them, I think we may expect about the same average acreage as last year, except, perhaps, in the newer areas. The Baganda have obviously less money with which to pay wages to employed labour, but the natives generally seem to be working on the principle 'Low prices this year, high prices next year.' There can be little doubt that the natives are becoming familiar with fluctuating markets, and although the price was certainly lower this past season, a more lucrative crop is not easily found. Moreover, as many of them say, 'If a man does not grow cotton, what is he going to do to pay his poll tax?' "

32. WEST AFRICA. *Report by the Hon. W. G. A. Ormsby-Gore, M.P. (Parliamentary Under-Secretary of State for the Colonies) on his Visit to West Africa during the year* 1926. (Cmd. 2744.)

Chapter II. of the Report is devoted to a general consideration of (the lack of) transport facilities in West Africa, and various suggestions for improvement are made. Chapter III. deals with Health, and calls attention to the great distance that has yet to be travelled before West Africa can become "a health resort." Agriculture and education are also dealt with. The Report goes on to deal with the Colonies individually, and contains at the end a useful large-scale map showing railways.

33. AUSTRALIA. *Cotton in Queensland.* (Abstr. from *Dalgety's Ann. Wool. Rev.*, 1925-26, p. 58.) The total yield of cotton harvested during the season is stated to be considerably less than last year, owing to adverse weather conditions, no rains of any material benefit falling during the planting season in September and October, and a very dry period being experienced in the growing season in January and February. Despite drought conditions, however, it can be safely stated that cotton compares favourably with other field crops, and there is no question of its suitability to Queensland conditions. Cotton farmers are beginning to realize that in order to make a success of cotton-growing it will be necessary to study more closely the question of soil moisture conservation, and to take steps to retain in the soil any rains which fall during the winter months.

34. *Cotton Cultivation in Queensland.* (Abstr. from *Queensl. Agr. Jnl.*, vol. xxvi., 3, 1926, p. 179.) The cotton industry has been affected by the abnormal dryness of the season, the total amount ginned by June 5 being only 5,147 bales, with little prospect of appreciable further increase. The yield per acre was as good as before, and a plot upon new land at Callide Research Station yielded from 1,200 to 1,500 lbs. seed cotton to the acre.

35. FIJI. *Possibilities of Extending Cotton Cultivation in Vitilevu and Vanualevu.* (Abstr. from the *Ann. Rept. of the Dpt. of Agr.*, 1925, p. 3.) The erection of a ginnery, improvement of transport facilities, and the opening of an Experimental Station are among the principal suggestions made by the cotton specialist, Mr. R. Anson, in his report under the above title.

36. *Cotton Cultivation.* (Abstr. from *Ann. Rpt. of the Dpt. of Agr.*, 1925, p 5.) From the report of the Cotton Inspector we learn that during the year under review some districts suffered from excessive rainfall. The area planted to cotton was approximately 400 acres, a decrease on the two previous seasons. The yield per acre was about 476 lbs. of seed cotton. Pink bollworm and cotton stainer have increased, and angular leafspot and black arm were also noticed.

37. WEST INDIES: BARBADOS. (Abstr. from the *Ann. Rpt. of the Dpt. of Agr.*, 1925-26.) The cotton crop of 1925-26 showed great promise in the early months, but the bolls were attacked at an early stage by pink bollworm, on a greater scale than in any previous year, with the result that on the whole the yield has been poor.

The system of experiments with cotton, with a view to improving the quality and increasing the yield of lint of the varieties of Sea Island cotton grown in the Island, was continued as in previous years.

38. St. Vincent. *Cotton Cultivation.* The latest advices state that during the quarter ended September 30 the cotton crop suffered from heavy and persistent attacks of caterpillars. Before the advent of these insects the crop was in a most promising condition. Bronze Beetle was moderately common, but was not responsible for any material damage.

COTTON IN EGYPT.

39. An Account of Experiments carried out to determine the Experimental Error of Field Trials with Cotton in Egypt. By M. A. Bailey and T. Trought. (*Tech. and Scientific Serv. Bull.*, No. 63. Obtainable from Govt. Publications Office, Min. of Finance, Dawawin P.O., Cairo. Price P.T. 10.) For comparative trials with Egyptian cotton in Egypt, it is recommended by the authors:

(1) That paths should not be left between beds, but that ridges adjacent externally to the bed should be uprooted at picking time.

(2) That variety beds should be repeated ten times.

(3) That trials should be carried out over a period of at least three years.

(4) That beds should be in the form of long strips (up to sixteen times as long as wide), and sited along the length of the ridges, to facilitate sowing. Where possible the area of the strips should be one-fifth feddan. Where sufficient land or seed is not available, the number of repetitions of one-fifth feddan strips should be reduced, and the strips divided into two or even three equal parts at harvest (each part being weighed separately), to maintain the requisite number of comparisons between adjacent beds.

(5) Results should be computed by the method of differences.

[*Cf.* letter from Mr. Trought in this issue.—Ed.]

40. Egyptian Cottons. *Improvement.* By V. M. Mosseri. (*Bot. Abs.*, 1926, **15**. Abstr. in *Summ. Curr. Lit.*, vi., **16**, 1926, E. 92.)

COTTON IN THE UNITED STATES.

41. Cost of Producing the Cotton Crop in 1925. (Abstr. from *Int. Cot. Bull.*, vol. v., **17**, 1926, p. 56.) The Department of Agriculture, Washington, has received reports from 1,405 cotton farmers for the purpose of ascertaining the cost of production. The greater number of the reports originate from growers with a much higher yield than the average of the whole of the country, consequently the final average arrived at is likely to be somewhat on the low side. The average yield of lint cotton in 1925 throughout the Cotton Belt was about 167 lbs. per acre. Two hundred and seven reports of the above 1,405 show yields of 141 to 180 lbs. per acre, or an average of 162 lbs. The Department of Agriculture states that "these reports, while limited in number, indicate that farmers who had average yields in 1925 produced lint cotton at an average cost of about 18 cents per pound."

42. American Cotton: Annual Review 1925-26 Season. (*Manch. Guard. Coml.*, August, 1926.) The usual valuable and interesting review, containing many useful articles, among which attention may be specially directed to that of D. B. Heard on "Outside Growths," in which an account is given of the work of the Empire Cotton Growing Corporation.

43. Proposed Universal Staple Standards for American Cotton. (Abstr. from the *Int. Cott. Bull.*, vol. v., **17**, 1926, p. 57.) In a memorandum presented to the United States Department of Agriculture, representatives of British and European Exchanges and Associations gave the following reasons for rejecting the proposal for the adoption of universal standards for staple length: (1) There is no general desire among buyers and users of cotton to accept the principle of universal standards for staple length; (2) such standards are not practicable: (*a*) in formulation, (*b*) in maintenance; (3) such standards would not be acceptable, as they only express one of the many characteristics required by the cotton trade. These headings are further discussed.

44. Cotton Spinning Tests in the U.S.A. By H. H. Willis. (*Text. World*, 1926, **69.** Abstr. from *J. Text. Inst.*, xvii., **9**, 1926, A. 283.) A short account of the work of the U.S. Department of Agriculture in co-operation with the textile department of Clemson Agriculture College in carrying out tests of the spinning values of raw cottons. Pima cotton has been shown to be equal to equivalent grades of Sakel. American, Egyptian, Sakel, and Sea Island cottons can be used in place of linen for airplane fabrics. Compression in the bale to high densities does not injure cotton provided the bale is not compressed when wet. The spinning value of a cotton is unaffected by fumigation with hydrocyanic acid gas. Special strains of Acala cotton grown in California were found to possess high spinning value. Pure varieties are superior to mongrel cotton in respect to waste, strength, and evenness of yarn.

45. Increases in Facilities for Handling Cotton in New York. (Abstr. from *Text. Rec.*, xliv., **521**, 1926, p. 98.) Members of the New York Cotton Exchange have authorized the Board of Management to execute a contract with the Bayway Terminal, which will set in motion plans for development which are expected to make New York one of the greatest cotton concentration ports in America. Under the contract, facilities for handling and storing cotton will be increased from 50,000 bales to 200,000 bales by October 1, 1927. The plans provide for transportation, handling, inspection, compressing, and insuring of cotton as low as any port in the country of comparable advantages.

46. North Carolina State College: Research Programme. By E. C. Brooks. (*Amer. Dyestuffs Rep.*, 1926, **15.** Abstr. from *J. Text. Inst.*, xvii., **9**, 1926, A. 292.) Some account is given of the work done in training textile technologists at the North Carolina State College of Agriculture and Engineering. A number of research problems are mentioned, including an inquiry into the chemical changes in cotton during storage, which is intended to determine the value of "curing" cotton before ginning.

47. Cotton Investigation in South Carolina. (*S. Carolina Sta. Rpt.*, 1925. Abstr. from *Exp. Sta. Rec.*, vol. liv., **7**, 1926, p. 636.) The further progress of experiments with cotton is described under the following heads: Fruiting studies; Spacing experiments; Seed and planting; Boll weevil control; Varieties; Fertilizers and rotations.

48. Cotton Experiments at Florence. By E. E. Hall and G. M. Armstrong. (Abstr. in *Exp. Sta. Rec.*, **54, 8,** 1926, p. 735.)

COTTON IN FOREIGN COUNTRIES.

49. Argentina. *Cotton Cultivation in Argentina.* From the Report of the Central Argentine Railway, Ltd., for the year ended June 30, 1926, we learn that the outstanding development in recent years has been the cultivation of cotton, which has made remarkable progress in spite of the difficulties with

which pioneers have had to contend. The chief obstacles encountered have been scarcity of labour, a continuous fall in prices throughout the past year, and last, but not least, inadequate means of transport. The principal cotton-growing zone lies in the National Territory known as the Chaco, and the Central Argentine Railway has presented an application to Congress wherein powers are sought for the construction of a line which would be the means of opening up this vast undeveloped area, and would thus give fresh impetus to the production of cotton.

50. BRAZIL. *São Paulo Cotton. The Cause of Declining Quality* (Abstr. from *Manch. Guard. Coml.*, November 4, 1926.) The cause of decline in export is considered to be chiefly decline in quality, owing to the mixture of varieties that is going on, while the import of fresh seed is prohibited. Damage by pink bollworm is partly responsible, and also careless picking and unsatisfactory ginning.

51. CHINA. We have received from the Department of Overseas Trade a copy of the "Report on the Commercial, Industrial, and Economic Situation in China to June 30, 1926," by A. H. George.

52. COTTON CULTIVATION IN PORTO RICO. By J. M. V. Colon. (*Bot. Abstr.*, 1926, **15**, 27. Abstr. in *J. Text. Inst.*, xvii., **9**, 1926, A. 246.)

53. COTTON CULTIVATION IN PORTO RICO. By J. F. Legrand. (*Bot. Abstr.*, 1926, **15**, 15. Abstr. in *J. Text. Inst.*, xvii., **9**, 1926, A. 246.)

54. We have received from the Association Cotonnière Coloniale a copy of Bulletin No. 76.

CULTIVATION AND MACHINERY: IRRIGATION.

55. FIELD CROP EXPERIMENTS IN ARKANSAS. *Ark. Sta. Bull.*, **203**, 1926. (Abstr. from *Exp. Sta. Rec.*, vol. lv., **1**, 1926, p. 29.) In endeavours to alter the oil and protein contents of cotton seed, high protein strains showed an increase of about 5 per cent. above the average protein content, while their oil contents remained near the average. The low protein group did not depart far from the average for cotton seed, but the oil content therein tended to increase. The increase of oil content in the high oil group was less marked than the increase of protein. Reduction of oil content appears to be accomplished more easily than increase. The protein content tends to rise as the oil content is reduced, whereas it remains quite constant during efforts to increase the oil content.

56. SOILS AND COTTON. THE RELATION BETWEEN SOIL PREPARATION AND A PROFITABLE YIELD. By "Germ." (Abstr. from *S. Afr. Cott. Growers' Jour.*, vol. iii., **2**, 1926, p. 17.) A good account of the methods of preparation of the soil, with the reasons for them.

57. SOME ASPECTS OF THE GEZIRA SOIL PROBLEM, AND ANALYSIS OF THE INFLUENCE OF RAINFALL ON THE YIELD OF COTTON AT THE GEZIRA RESEARCH FARM, SUDAN. By E. M. Crowther. (*Wellcome Tropical Res. Labs.*, Khartoum, Sudan.)

58. FERTILISING COTTON. By "George I.," M.A. (*South Afr. Cott. Growers' Jnl.*, vol. iii., **3**, 1926, p. 31.)

59. COTTON PICKER. (Abstr. from the *Courier*, Brisbane, September 9, 1926.) A cotton-picking machine, which, it is claimed, can pick cotton ten times as fast as the hand-picker, has been invented by Mr. W. A. Preston, of Brisbane. Air compression is used, and it is estimated that in a day of eight hours about 700 lbs. of cotton could be picked.

60. A Day in the Life of a Cotton Ginner. By "Ginner." (*Afr. Land and Home Jnl.*, ii., **4**, 1926, p. 3.)

61. Cottonseed Meal for Cows. (Abstr. from *Dalgety's Rev.*, New South Wales, June 25, 1926, p. 6.) Cottonseed meal is stated to possess over three times the feeding value of barley-meal and maize-meal, over two and a quarter times that of bran and pollard, and over one and a half times that of linseed-meal. The suggested daily allowance of cottonseed meal for a cow is from 2 to 3 lbs.

DISEASES, PESTS, AND INJURIES, AND THEIR TREATMENT.

62. Demonstration on the Relationship between Soil Conditions and the Incidence of Insect Pests. By H. W. Bedford, Asst. Govt. Entomologist, Gezira, Sudan. (*Wellcome Trop. Res. Labs.*, Khartoum, Sudan.)

63. Application of Sodium Silicofluoride. By F. Tattersfield and C. T. Gimingham. (*And. Eng. Chem.*, 1925, **17**. Abstr. from *Agr. Jnl. of India*, xxi., Pt. 5, 1926, p. 408.) Some experiments have been made on the toxicity of sodium and potassium silicofluorides, and other related compounds, as stomach poisons for insects when used in the form of spray fluids. The results are in general agreement with those of Macrovitch, who used the sodium compound in the form of dust, and support the view that this substance has interesting possibilities as an insecticide. Some data are given, and it is stated that the toxicity was slightly, but probably not significantly, less when 1 per cent. of saponin was added to the spray fluid. The foliage of the hazel twigs, which was sprayed with very fine suspensions of the silicofluoride in water, was uninjured.

64. The "Cloud Drift" versus the Regular Method of Dusting. By W. E. Hinds. (Abstr. in *J. of Econ. Ent.*, vol. xix., **4**, 1926, p. 607.)

65. The Use of the Aeroplane for Applying Insecticides. By A. D. Imms. (Abstr. from *Rev. of Appl. Ent.*, vol. xiv., Ser. A., Pt. 8, 1926, p. 399.) A review of work that has been done in various parts of the world with aeroplanes for applying insecticidal dusts.

66. The Breeding of Boll Weevils from Infested Cotton Squares. By B. Gohauf. (Abstr. in *J. of Econ. Ent.*, vol. xix., **4**, 1926, p. 593.)

67. Weevil Biological Work. (*S. Carolina Sta. Rpt.*, 1925. Abstr. from *Exp. Sta. Rec.*, vol. liv., **7**, 1926, p. 662.) A brief account of biological studies of the boll weevil by F. A. Fenton, E. W. Dunnam, *et al.*

68. Cotton Boll Growth in Relation to Boll Weevil Injury. By E. W. Dunnam. (Abstr. from the *J. of Econ. Res.*, vol. xix., **4**, 1926, p. 589.) This paper gives evidence that as the cotton bolls grow older they are less susceptible to boll weevil, *Anthonomus grandis*, injury, and the immunity at given ages varies with the variety. Dixie Triumph, Webber 49, and Humco Cleveland were the varieties studied; the first mentioned is the most susceptible, and the last the most resistant. There is no correlation between the number of feeding punctures or the number of egg punctures and the percentage of cotton loss. Neither is there any relation between the thickness of hull and susceptibility to weevil damage, in spite of the fact that the weevils lay fewer eggs in the thick-hulled varieties. The determining factor is the hardness of bolls, because varieties with the hardest bolls, as determined by the number of grams pressure required to puncture them, show also the least per cent. of cotton loss.

69. Boll Weevil Control Tests. By S. H. Starr. (Abstr. in *Rev. of Appl. Ent.*, vol. xiv., Ser. A., Pt. 9, 1926, p. 476.)

70. Boll Weevil Control Results for 1925. By W. E. Hinds. (Abstr. in *J. of Econ. Ent.*, vol. xix., **4,** 1926, p. 599.)

71. Comparative Tests with Sodium Fluosilicate and Calcium Arsenate for the Control of the Cotton Boll Weevil (*Anthonomus grandis.*) By M. R. Osburn. (Abstr. in *J. of Econ. Ent.*, vol. xix., **4,** 1926, p. 643.)

72. Dusting Cotton with Calcium Arsenate for Boll Weevil Control. By J. M. Robinson. (Abstr. in *Rev. Appl. Ent.*, xiv., **10,** Ser. A., 1926, p. 491.)

73. Dusting Controls the Boll Weevil. By J. O. Pepper. (Abstr. in *Exp. Sta. Rec.*, **54, 8,** 1926, p. 757.)

74. The Pink Bollworm, with Special Reference to Steps Taken by the Department of Agriculture to Prevent its Establishment in the United States. By W. D. Hunter. (*U.S. Dpt. of Agr. Bull.*, No. 1,397, Washington, 1926.) One of the best general accounts of the Pink Bollworm, its life-history and its spread, that we have yet seen, and one that should be in the hands of all entomologists who have to deal with this pest.

In 1842, the superintendent of the Government cotton plantations at Broach, India, sent specimens of a very destructive cotton insect to the distinguished English entomologist, W. W. Saunders. They were described as a new species, *Depressaria* (now *Pectinophora*) *gossypiella*, Saund., in 1842. The next statement with regard to its attack on cotton was not until 1904, from German East Africa, and in 1909 it was described from the Hawaiian Islands as apparently lately introduced from India. Since 1913 a considerable literature has been built up.

The original home is considered to be India, and possibly other parts of South Asia, but its present range covers most of the cotton-growing countries of the world.

A detailed description and life-history of the insect is then given with diagrams, and with figures of the damage done on the bolls. Lists of plants that have been observed as supplying food (mostly Malvaceæ) are given, with an account of natural enemies, nature and extent of damage done, and finally the precautions taken to prevent its introduction into the United States. The insect was first discovered in Texas in 1917, and a detailed account is given of all the work that this and subsequent appearances have made necessary. Finally, the present status of the question is reviewed.

75. Etwas über den roten Kapselwurm. By A. Andres. (Abstr. from *Rev. Appl. Ent.*, vol. xiv., Ser. A., Pt. 7, 1926, p. 359.) This is a review of the problems connected with the recent spread of *Platyedra gossypiella*, Saund., throughout the cotton-growing regions of the world.

76. The Genus Platyedra (Cotton Pink Bollworm Genus) in Australia. By H. Tryon. (Abstr. from *Rev. of Appl. Ent.*, vol. xiv., Ser. A., Pt. 7, 1926, p. 334.) The occurrence of *Platyedra gossypiella*, Saund. (Pink Bollworm), and of possible races of it in Australia, is reviewed.

77. The Pink Bollworm in Queensland. By F. G. Holdaway. (Abstr. from the *Rev. of Appl. Ent.*, vol. xiv., Ser. A., Pt. 9, 1926, p. 459.)

In 1924, when a strong effort was being made in Queensland to re-establish the cotton industry on a commercial scale, it was reported that the Pink Bollworm, *Platyedra gossypiella*, Saund., had been discovered there. Recent investigation, however, shows that the insect occurring in Queensland is distinct from *P. gossypiella* ; it is distinguished from it on larval and pupal characters, and is here described as *P. scutigera*, sp. n. A discussion of infestation, life-history, and distribution follows. There are also two other species of Platyedra

occurring on native Malvaceæ in Queensland, but although they are both present in cotton-growing localities, they have never been found to attack the crop. The present knowledge of the food-plants of these four species in Australia is detailed. The true *P. gossypiella* apparently only occurs in Western Australia and the Northern Territory.

78. A NEW CORN AND BOLLWORM FROM PERU (*Lepidoptera, Pyralidæ*). By H. G. Dyar. (Abstr. from *Exp. Sta. Rec.*, liv., **8,** 1926, p. 755.) Under the name of *Jocarula agriperda*, n. g. and sp., the author describes a new lepidopteran, the larvæ of which were reared from the tips of ears of corn and also from cotton bolls, which they usually enter at the tip, and end by boring into the seeds. Through their attacks bolls were altered and developed prematurely. Their attack on cotton was observed in the valleys of Cagneto and Lima.

79. LIFE-HISTORY AND HABITS OF THE THURBERIA BOLLWORM (*Thurberiphaga diffusa*, Barnes). By C. T. Vorhies. (Abstr. from *Rev. Appl. Ent.*, xiv., **10,** Ser. A., 1926, p. 530.) Gives the results of field and laboratory studies of *T. diffusa* extending over five years. All stages are described and illustrated.

80. THE LIFE-HISTORY OF *Tectacoris lineola*, F., AND ITS CONNECTION WITH INTERNAL BOLL ROTS IN QUEENSLAND. By E. Ballard and F. G. Holdaway. (*Bull of Ent. Res.*, vol. xvi., Pt. 4, 1926.) The insect whose life-history is described is one which is the cause of very widespread damage to cotton in Queensland. Its effect on the plant is similar to that of *Dysdercus spp.* in other cotton-growing countries, but its importance depends upon the fact that it does not replace the local species of *Dysdercus*, but augments the loss which that insect causes. *Tectacoris* is early in the field, even before the first flowers appear, while *Dysdercus* holds off until the opening of the bolls. In consequence of this, boll-rot fungi occupy a premier position among the pests of cotton in Queensland.

A general account is given of the habits and distribution of *Tectacoris lineola*, together with a description of the adult, and some remarks on the influence of weather conditions on mating. The eggs and the different instars are described, and the period of time occupied by each is given. The connection between *Tectacoris lineola* and boll-rot incidence is established.

A table is included illustrating the comparative effect of boll rots and bollworm damage in the past season (1924-25) on the Cotton Research Farm at Biloela.

The effect of bug punctures on cotton seed, and its infection with *Fusarium moniliforme*, are briefly discussed.

81. THE COTTON FLEA (LEAF HOPPER). By Professor A. B. Cox. (Abstr. from *Int. Cot. Bull.*, vol. v., **17,** 1926, p. 53.) What is popularly known as the "cotton flea" is not a flea at all. It is also not a new insect, and is, in fact, a leaf hopper. The insect is probably the same as the jassid which attacked the cotton in South Africa this year. It has been observed in the cotton fields of the United States for years, and at times—especially in the fall, when the season was wet and warm—has become quite numerous, though until recently it was considered comparatively harmless. The insect began to be regarded as doing serious damage about 1920, and this season has been the worst.

The damage done by the cotton leaf hopper is a result of its feeding habits. Soon after it is hatched it seeks the tenderest part of the plant, the terminal bud clusters on the vegetative as well as the fruiting branches, and continues to prefer feeding at such places throughout its life. The insect has a sharp beak, which it inserts through the outer skin of the plant, and sucks the juices. The wound is slight, but the hopper moves rather rapidly from one place to another,

so that if there is considerable infestation one small square at the terminal bud may receive many punctures. It is generally conceded that these wounds, and the loss of nourishment, are the chief cause of the death of the square. Whether the damage is due entirely to the wounds and loss of plant food or to some poisoning effects is not known. In addition to actually killing the fruit in the early stages of its formation, there is more or less injury to the plant itself, in that the hoppers tend to prevent its proper development, particularly of fruiting branches. Wherever there has been heavy infestation the stalks are tall and spindled, points tend to be long, and there is a striking absence of fruiting branches.

It is generally conceded by entomologists that the best way to avoid damage from cotton leaf hoppers is through cultural methods. In the first place, they pass through the winter in the egg stage, which are attached to weeds and cotton stalks. These should be destroyed. They usually hatch out in the spring, before cotton is large enough to feed on, and since they must live on weeds for a time, these should be kept down. If preventive methods are not used, or are not effective, the hopper may be controlled by spraying the cotton with a fine sulphur dust about every ten days. From ten to fifteen pounds of sulphur per acre are required, depending on the size of the cotton. Proper control methods are usually effective in preventing serious damage.

82. Notes on the Aphididæ of Egypt. By W. J. Hall. (*Tech. and Sci. Serv. Bull.*, No. 68. Obtainable from Govt. Publications Office, Min. of Finance, Dawawin P.O., Cairo. Price P.T. 5.) Among the insects dealt with is the *Aphis gossypii*, Glover, probably the commonest *Aphis* found in Egypt. A list of the host plants is included.

83. Biology of the Parasites and Hyperparasites of Aphids. By H. Spencer. *Ann. Ent. Soc. Amer.*, xix., **2**, 1926. Abstr. from *Rev. Appl. Ent.*, xiv., **30**, Ser. A., 1926, p. 485.) These observations on the parasites and hyperparasites of Aphids were begun in North Carolina in 1920, and continued in Ohio in 1921 and 1922. The existing literature on the subject is reviewed, and the apparatus and methods employed in the rearing experiments are described. The biological factors affecting the control of Aphids include the condition of the food-plant, fungous diseases, and predatory and parasitic insects, but their relative efficiency varies with the time of year and differences in weather conditions.

84. Insects Affecting Cotton in Australia. By G. F. Hill. (Abstr. from *Rev. Appl. Ent.*, vol. xiv., Ser. A., Pt. 7, 1926, p. 336.) The following insects have come under the author's personal observation as pests of cotton in the Northern Territory of Australia: Lepidoptera, *Earias fabia*, Cram., *E. huegeli*, Rog., *Platyedra gossypiella*, Saund., and *Pyroderces pyrhodes*, Meyr.; and Rhynchota, *Oxycarenus arctatus*, Wlk., *Tectacoris lineola*, F., and *Dysdercus cingulatus*, F. *Earias smaragdina*, Butl., also occurs in the Northern Territory, but its food plants are not known. *T. lineola* appears to be comparatively scarce, but the other pests are all important, *E. fabia*, *E. huegeli*, and *Platyedra gossypiella* being the most destructive. Their distribution in other parts of Australia is discussed.

The Chalcid, *Bephratella sarcophaga*, Gir., and an unidentified Ichneumonid are important natural enemies of *E. huegeli* in the Northern Territory. The eggs of *T. lineola* are parasitized by the Proctotrupid, *Telenomus darwiniensis*, Dodd.

85. Insects Injurious to Cotton in Turkestan. By V. I. Plotnikov. (Abstr. in *Rev. Appl. Ent.*, xiv., **10**, Ser. A., 1926, p. 507.)

86. Cotton Pests: Venezuela. By A. I. Roberto. (*Bol. Abs.*, 1926, **15**. Abstr. from *Summ. of Curr. Lit.*, vi., **16**, 1926, E. 94.) *Alabama argillacea* and possibly *Heliothis* sp. cause important damage to the cotton crop in Venezuela. Control measures are outlined.

87. Calendario de Patalogia Vegetal y Zoologia Economica, I. Plagas de Origen Animal (*insectos, acaros, etc.*) (Argentina, *Min. Agr.*, Circ. 610. Abstr. from *Rev. Appl. Ent.*, xiv., **7**, 1926, p. 360.) The agricultural pests common in Argentina are listed according to the season of the year, with brief notes on their habits and control. The following cotton pests are mentioned: *Alabama argillacea, Heliothis obsoleta, Aphis gossypii, Dysdercus ruficollis, Gargaphia subpilosa, Platyedra gossypiella.*

88. The Work of the North-Caucasian Aviation Expedition for the Control of Locusts. By P. A. Sviridenko. (Abstr. from the *Rev. of Appl. Ent.*, vol. xiv., Ser. A., Pt. 8, 1926, p. 395.) A preliminary account of the first aeroplane campaign against locusts, which showed that it is possible to destroy them in reed-beds by dusting, such areas being inaccessible to the usual methods of applying sprays or dusts. Of the various dusts tried, Paris green and sodium arsenite gave the best results when applied at the rate of 10-12 lbs. to 3 acres if broadcast, or 4-5 lbs. if applied in strips. These dusts will penetrate dense fields up to 16 feet high, and adhere well to the foliage and even the stems.

89. Etat Actuel de l'Organization de la Lutte contre les Sauterelles dans divers Pays. Resultats d'une Enquete Internationale. By G. Trinchieri. (Abstr. from *Rev. Appl. Ent.*, vol. xiv., Ser. A., Pt. 7, 1926, p. 347.) Deals with the locust and its control.

90. Le Problème acridien. By P. Vayssière. (Abstr. in *Rev. Appl. Ent.*, vol. xiv., Ser. A., Pt. 7, 1926, p. 347.) Deals with the locust problem in different countries.

91. Cotton Wilt Disease. By J. F. Dastur. (*Rpt. of Dpt. of Agr. Cent. Provs. and Berar*, 1924-25. Abstr. from *Rev. Appl. Mycol.*, v., **10**, 1926, p. 594.) Inoculation experiments with the *Fusarium* believed to be the cause of wilt disease of cotton at Dharwar again gave negative results. The *Fusarium* usually present in wilted cotton plants in the Central Provinces was further shown to occur both in "wilting" and "non-wilting" soils; this organism is similar to the Dharwar fungus, and to that described by Ajrekar and Bal. Field and pot culture experiments were greatly hampered by the incidence of the *Rhizoctonia* disease, which was responsible for heavy losses. Promising results as regards resistance to wilt were given by a variety of cotton supplied by the Economic Botanist. *Gossypium roseum* and *G. neglectum verum* (strain AK2) are stated to be highly susceptible, while AK4 is very resistant.

92. The Wilt Diseases of Cotton and Sesamum in India. By E. J. Butler. (Abstr. from *Agr. Jour. of India*, vol. xxi., Pt. 4, 1926, p. 268.) Describes some work carried out in 1912, which gives evidence that cotton wilt is caused by a *Fusarium* which is capable of pathogenic action under certain conditions not yet elucidated, and that these conditions are probably not connected with the composition of the soil, as has been suggested by J. F. Dastur.

93. The Cause of Cotton Wilt in India. By S. L. Ajrekar. (Abstr. from *Rev. of Appl. Mycol.*, vol. v., Pt. 8, 1926, p. 489.) Further experiments on cotton wilt go to prove the parasitic nature of the *Fusarium* strains from Dharwar and Nagpur that were employed. The writer finds unconvincing Dastur's reasons for doubting the parasitism.

94. Cotton Root Rot in Texas. (*38th Ann. Rpt. Texas Agr. Exp. Sta.*, 1925. Abstr. from *Rev. Appl. Mycol.*, v., **7**, 1926, p. 405.) During the period from September 1, 1924, to August 31, 1925, an extensive study was made of cotton root rot (*Phymatotrichum omnivorum*). In the central regions of Texas the vine *Ipomœa trichocarpa* is stated to be by far the most important summer and winter

carrier of the disease. The cumulative effects of sulphur treatment reduced the incidence of infection to a minimum, but were not beneficial to the cotton. Large numbers of spores of *P. omnivorum* were found in irrigation ditches a few days after irrigation. Successful germination of the spores was obtained by the removal of the waxy sheath which normally prevents them from absorbing water. The development of the fungus was found to be completely inhibited by 0·20 per cent. of normal hydrochloric acid, 0·21 per cent. of normal sulphuric acid, or 5·50 per cent. of normal sodium hydroxide.

95. Cotton Root Rot. By J. C. Luthra. (*Rpt. Dpt. of Agr. Punjab*, 1925. Abstr. from *Rev. Appl. Mycol.*, v., **10**, 1926, p. 595.) The incidence of root rot of cotton was found to be reduced from 34 to 8 per cent. by trenching operations. The removal of kankar (concretionary limestone) also gave beneficial results.

96. A Leaf, Bract, and Boll Spot of Sea Island Cotton caused by *Helminthosporium Gossypii* n. sp. By C. M. Tucker. (*J. Agr. Res.* [*U.S.*], **32**, 1926, no. 4. Abstr. from *Exp. Sta. Rec.*, vol. liv., **9**, 1926, p. 846.) A description is given of a disease of Sea Island cotton causing spots on leaves, bracts, and bolls, which is present generally in the principal cotton-growing sections of Porto Rico. The author isolated a species of *Helminthosporium* from the diseased tissues, studied it in pure culture, and reproduced the disease through inoculation. The fungus is described as *H. gossypii* n. sp. It is said not to infect the seeds, and to be more severe under drought than under humid conditions.

97. Plant Diseases. (*Arkansas Sta. Bull.*, **203**, 1926. Abstr. from *Exp. Sta. Rec.*, vol. lv., **1**, 1926, p. 41.) Studies of cotton diseases in Arkansas are said to indicate the presence of more or less distinct strains of the wilt fungus (*Fusarium vasinfectum*), and that environmental conditions are important factors in the incidence of the disease. Tests are said to be in progress to determine varietal resistance to wilt, and the parasite has been found to cause a damping-off of cotton seedlings. Cotton plants placed in filtered extracts of media, in which the fungus has been grown, wilted, indicating that the injury is due to toxic principles, and not to the plugging of the vascular bundles of the host.

The disease of cotton caused by *Ascochyta gossypii*, first described from Arkansas, but since reported from other States, has been found to be dependent on weather conditions for its occurrence.

98. Diseases of Field and Vegetable Crops in the United States in 1925. By R. A. Jehle and J. I. Wood. (*Plant Dis. Rep.*, Supplement 45, 1926. Abstr. from *Rev. Appl. Mycol.*, v., **10**, 1926, p. 597.) Cotton blight (*Ascochyta gossypii*) was again reported from North and South Carolina, and recorded for the first time in Alabama and Mississippi. In the first-named State, the disease assumed an epidemic form in the wet season of 1924, whereas in the dry summer of 1925 it was much less serious. In Mississippi, the plants in the small infected area were completely destroyed.

A very severe outbreak of cotton leaf spot caused by *Alternaria* sp. was reported from the Salt River Valley of Arizona in 1925, the disease occurring also in Virginia, Mississippi, Arkansas, and California. The humid weather conditions in the early autumn in Arizona appear to have been particularly favourable to the rapid development of the fruiting stage of the fungus. Infection was most severe on the Pima long staple variety, and caused early defoliation.

99. Plant Diseases. (*S. Carolina Sta. Rpt.*, 1925. Abstr. from *Exp. Sta. Rec.*, vol. liv., **7**, 1926, p. 648.) The Ascochyta canker of cotton, first reported in the State in 1924, was found again in 1925.

BREEDING, GENERAL BOTANY, ETC.

100. COTTON PLANTS. DESCRIPTION. (*Ind. Eng. Chem.*, 1926, **18**, 864. Abstr. from *Summ. Curr. Lit.*, vi., **16**, 1926, A. 43.) The discovery of several new types of cotton in the West Indies and South America is reported by members of the U.S. Department of Agriculture Bureau of Plant Industry. One of the new types of cotton plants has bracts that are open or turned back from the buds and young bolls, so that little protection is afforded for boll weevils or other pests.

101. CHANG YIN SHA MIEN COTTON. CHARACTERISTICS. By T. S. Kuo and F. M. Chou. (*Bot. Abs.*, 1926, **15**, Abstr. from *Summ. Curr. Lit.*, vi., **16**, 1926, E. 92.) The origin of the "Chang Yin Sha Mien" variety and the detailed plan of its line breeding are described. The pure line of the variety runs well through five years' breeding test (self-pollination). This cotton is said to be the best Chinese variety, and it has the following characters: Staple length, about 1 inch; lint index, 5 gm.; lint percentage, 35-42; early maturity, big boll and high yield. The quality of the fibre, however, is coarse, and the plant has very low resistance to the attack of leaf-roll disease. Field records of plant growth are tabulated.

102. ROOT-GROWTH IN THE COTTON PLANT. RELATIONSHIP TO OXYGEN-SUPPLY AND TO TEMPERATURE OF SOIL. (Abstr. from *Trop. Agriculture*, vol. iii., **8**, 1926, p. 174.) In the Year Book of the Carnegie Institute of Washington, U.S.A., no. 23, for 1923-24, pp. 136-8, Dr. W. A. Cannon summarizes some very striking results that have been obtained in studies of the effect of certain soil factors on the growth of the roots of cotton plants. In particular, it has been demonstrated that two factors, namely, oxygen-supply and soil temperature, are closely inter-related in their positive effects on root-growth. Thus, when the partial pressure of oxygen in the soil atmosphere is adequate (as in well-tilled soil), the rate of root-growth may be modified directly by a change of soil temperature. Conversely, when soil temperature is suitable and constant, a change in the partial pressure of oxygen, provided it is relatively low, directly affects, within certain limits, the rate of growth of the root. In this instance, an oxygen deficiency may obtain, and soil temperature may then be the limiting factor for root-growth. Hence oxygen deficiency is merely a relative term, depending largely on soil temperature.

Recently, Dr. Cannon has investigated the direct effect of soil flooding on root-growth in the cotton plant (Carnegie Institute Year Book, No. 24, 1925, p. 296). He has shown by experiments with sand cultures that the growth-rate of the main roots of cotton plants may be greatly decreased by flooding the soil, and that it may even cease from this cause. The result may be solely due to a sudden diminution of oxygen concentration in the soil-water accompanying flooding, whereby the oxygen-content of the soil becomes much lower than the critical partial pressure for root-growth at the temperature obtaining in the environment.

103. BAGGING COTTON FLOWERS TO PREVENT ACCIDENTAL CROSS-POLLINATION. By T. H. Kearney and D. D. Porter, U.S. Dpt. Agr. (*J. of Hered.*, **17**, 1926, p. 273.) At Sacaton Field Station the flower buds are enclosed early in the morning in half-pound paper bags. Though excellent with Egyptian, this method does not work so well with other cottons, and Upland flowers are more satisfactorily treated by being kept closed by a rubber band or spiral of copper wire. The sides of the bag are slit, and it is placed astride the fruiting branch on which the bud is borne, and fastened together below it. Two hundred flowers can be bagged in an hour, and labels may be attached to the bags giving details in hybridization work, etc. Bagged flowers produce less seed than unbagged, and white bags are found most efficient.

104. Reversing Spiral Measurements of Cotton Hair. By W. L. Balls and H. A. Hancock. (*Proc. Roy. Soc.*, 1926, 99 B., Abstr. from *Agr. Jnl. of India*, xxi., pt. 5, 1926, p. 410.) Selections from a mass of statistical data describing the dimensions and form of the spiral arrangements which occur in the cell wall of cotton hairs are presented. The spirals may be dexter or sinister, and their reversals are apparently predetermined during growth in length. Genetic and ordinary environmental influences do not affect the statistical peculiarities of the reversals. The final adult length of the hair, and the time taken in reaching that length, do not affect the reversal distribution. Nearly all the seed hairs of *Gossypium* begin to grow on a sinistral spiral—*i.e.*, the opposite hand to an ordinary screw thread. The basal sinistral spiral increases in length, is broken up, and later additions may be made to its fragments. Similar extension, fragmentation, and subsequent addition take place with the later dextral spiral. The angle of the helix varies somewhat around two modal values, namely, approximately 27° dexter and 27° sinister. The local variations of the angular value are quite unaffected by inversion of the "hand" of the angle from dexter to sinister. Dexter and sinister wall structures have been found in some hairs to have different structural properties in their resistance to collapse after the death of the cell. A tentative explanation of the cause of reversal is offered, but attention is drawn to its insufficiency and to the need for experimental evidence.

105. Photoperiodic Plants and Cotton Plant: Effect of Temperature and Humidity on Vegetative Activity. By B. E. Gilbert. (*Ann. Bot.*, 1926, **40**. Abstr. from *J. Text. Inst.*, xvii., **10**, 1926, A. 294.) This paper is an account of the results obtained with certain plants known to respond to relative day length when grown under two controlled sets of temperature and humidity. The plants investigated included cotton, as likely to be very sensitive to temperature variations. Marked results were obtained in the modification of the length of the vegetative activity. Soya beans and cotton exhibited definite reactions to the higher temperature and lower humidity conditions. Definite retardation of flowering was noted with the lower temperature and higher humidity conditions.

CO-OPERATION.

106. Co-operative Cotton Marketing Spreads. By W. Whittam. (Abstr. from *Text. Rec.*, xliv., **521**, 1926, p. 50.) During 1925-26 the bales received by the large-scale co-operative societies in America were 1,488,650, or 9·3 per cent. of the total crop. The proportion has increased from 5·2 per cent. in 1921-22.

LEGISLATION.

107. Australia. *The Cotton Bounty Act of* 1926 provides for the payment of a Bounty on the Production of Seed Cotton and Cotton Yarn.

108. Protection des Colonies Françaises contre le "Ver Rose" du Coton. (Abstr. from *Rev. of Appl. Ent.*, vol. xiv., Ser. A., Pt. 8, 1926, p. 404.) An Act prohibiting the importation into all French colonies, except Madagascar, of any plant that may carry Pink Bollworm.

109. India. *Notification No.* 932-*Agri.* of May 19, 1926, amends Paragraph 2 of Notification No. 1493-A. of November 14, 1925.

Notification No. 933-*Agri.* of May 19, 1926, amends Paragraph 1 of Notification No. 1561-A. of November 26, 1925.

110. New Guinea. *Quarantine Proclamation No.* 7, dated February 22, 1926, prohibits the importation into the Territory of cotton plants, cotton seed, un-

ginned cotton or "seed cotton," and raw cotton, except under a written permit obtained from the Director of Agriculture. All imported cotton seed to be accompanied by a certificate of disinfection from the Department of Agriculture and Stock, Queensland.

A Proclamation of the Deputy Administrator, dated April 10, 1926, repeals Proclamation, dated March 28, 1923, prohibiting the importation of cotton seed into the Territory unless first certified by the Department of Agriculture, Queensland, as being free from disease.

A Proclamation of the Deputy Administrator, dated April 10, 1926, repeals Proclamation, dated April 18, 1923, prohibiting the importation of Raw Cotton, technically called Lint, into the Territory unless first certified by the Department of Agriculture, Queensland, as being free from disease.

111. NIGERIA. *Ordinance No.* 4 of March 15, 1926, enables the Governor in Council to make regulations for the prevention of the introduction or spread of pests and insects destructive to trees, plants, and crops, and for the control of cotton-growing and of the preparation and export of cotton and other agricultural produce.

112. NYASALAND. *Proclamation No.* 25 of 1925 provides that after July 1, 1926, no cotton shall be moved from the North Nyasa District to any place outside the said district unless same be baled cotton lint fumigated or otherwise treated as deemed necessary by the Director of Agriculture (or his representative). Such cotton, after treatment, to be moved only along routes and by such means as may be approved by the Director of Agriculture. All directions given by the Director of Agriculture regulating the movement in and export from the said district of cotton, seed seed cotton, or cotton lint to be strictly complied with.

113. COTTON GROWING DECREE IN FORCE IN ALL THE PORTUGUESE COLONIES. No. 11994, dated Lisbon, July 28, 1926. (Abstr. from the *Int. Cott. Bull.*, v., **17**, October, 1926, p. 33.) Those who are interested in cotton legislation would do well to read this article carefully, as the legislation covers all the various points in which growers need proper protection by law, such as supply of seed, burning of old plants, licences for purchase, fixing of prices, organization of markets, and installation of ginneries.

114. RHODESIA (SOUTHERN). *Government Notice No.* 484 of August 20, 1926, prohibits the introduction into Southern Rhodesia from Northern Rhodesia of cotton lint, cotton seed and seed cotton, except under certain specified conditions. Regulations are also included governing the transit of cotton lint and cotton seed from Northern Rhodesia through Southern Rhodesia. This Notice cancels Notice No. 336 of 1924 and Notice No. 156 of 1925.

115. TANGANYIKA. *Government Notice No.* 26 of March 17, 1926, states the fees payable for the year ending March 31, 1927, in respect of licences under the Cotton Rules, 1922.

116. UNITED STATES. *Amendment No.* 5 *to Service* and Regulatory Announcements (Agricultural Economics) No. 91 amends Section 4 of Regulation 13 of the Cotton Futures Act of May 31, 1920.

Amendment No. 3 to Service and Regulatory Announcements (Agricultural Economics), No. 95, amends Section 5 of Regulation 8, Sections 3, 7, 8 and 10, of Regulation 9, Paragraph 2 of Section 1 of Regulation 11, and Sections 1, 3, and 4 of Regulation 13 of the Cotton Standards Act of March 4, 1923.

117. PINK BOLLWORM QUARANTINE (DOMESTIC). PINK BOLLWORM SITUATION. (Abstr. from *Rev. Appl. Ent.*, vol. xiv., Ser. A., Pt. 7, 1926, p. 358.) The situation as regards Pink Bollworm (*Platyedra gossypiella*, Saund.) in Texas in 1925 is

discussed, with sketch maps showing the districts infested in 1920 and 1925. More drastic control of movement and of road inspection is required, and, if possible, the maintenance of a non-cotton zone. Regulations are enforced by proclamations of August and November, 1925, to ensure that all cotton and cotton products in infested areas are given vacuum fumigation prior to movement interstate out of these areas, and to prohibit the movement of cotton seed from them.

CHEMISTRY AND PHYSICS IN THEIR RELATION TO COTTON PROBLEMS.

118. RAW COTTON. OPENING. By M. C. (*Cotton* [U.S.], 1926, **90**, 551-556. Abstr. in *J. Text. Inst.*, xvii., **9**, 1926, A. 258.)

119. COTTON YARNS: WET SPINNING. By N. Alexeeff and G. Petroff, Moscow. (Abstr. in *J. Text. Inst.*, xvii., **9**, 1926, A. 263.)

120. THE EFFECT OF HUMIDITY ON THE THERMAL CONDUCTIVITY OF WOOL AND COTTON. By H. Staff. (Abstr. in *Exp. Sta. Rec.*, **54**, **8**, 1926, p. 795.)

121. COTTON MILLS. HUMIDIFICATION. By D. M. Amalsad. (*In. Text. J.*, 1926, **36**. Abstr. from *Summ. Curr. Lit.*, vol. vi., **19**, 1926, M. 31.) The principles underlying humidification are explained in simple language, and practical methods of humidifying the air of a mill are outlined.

122. RAW COTTON. OILING. (*Nat. Asscn. Cotton Mnfrs., Bull.*, No. 72, 1926. Abstr. from *Summ. Curr. Lit.*, vi., **16**, 1926, F. 24.) The following results were obtained in a series of experiments in which oiled and untreated dyed cotton were run simultaneously on adjacent machines. There was no visible change in running quality in the pickers, and the percentage of waste removed by the beaters was substantially unchanged. There appeared to be slightly less fly round the cards running on oiled cotton, but the difference in actual waste was negligible. There was an improvement in the running of the oiled cotton in the drawing, roving, and spinning processes. In roving and spinning, the end breakage was appreciably lower, and in the slubber roving the amount of waste was less. No marked difference in the amount of fly was detected. Under the conditions of the test, the average yarn strength of the oiled cotton was less than for the regular cotton. Further tests indicated that the effects of oiling were most evident in carding, spinning, and in the yarn itself. In carding, the invisible loss was much less, and in spinning the number of ends down was less, and the variation in breaking load of the individual samples was reduced. The breaking load was consistently lower, and the yarn showed more variation in count on the individual samples.

123. TEXTILE FIBRES: MICROSCOPIC AND MICRO-CHEMICAL EXAMINATION. By F. Pichler. (*Leipzig. Monats. Text-Ind.*, 1926, **41**. Abstr. in *J. Text. Inst.* xvii., **9**, 1926, A. 287.)

124. ABSORBENT COTTON: GRADING. By A. Lohmann. (*Chem. Abs.*, 1925, **19**, 376. Abstr. in *J. Text. Inst.*, xvii., **9**, 1926, A. 286.)

125. RECENT CONTRIBUTIONS TO THE CHEMISTRY OF THE COTTON PLANT AND ITS PRODUCTS. By C. A. Browne. (Abstr. in *Exp. Sta. Rec.*, liv., **8**, 1926, p. 707.)

126. COTTON. ACTION OF LIGHT. By H. Kauffmann. (*Melliand's Textilberichte*, 1926, **7**. Abstr. in *Summ. Curr. Lit.*, vi., **16**, 1926, C. 126.)

127. THE ODOROUS CONSTITUENTS OF THE COTTON PLANT. EMANATION OF AMMONIA AND TRIMETHYLAMINE FROM THE LIVING PLANT. By F. B. Power and V. K. Chesnut. (Abstr. from *Exp. Sta. Rec.*, vol. liv., **9**, 1926, p. 803.) An

extensive investigation of the concentrated distillate from the cotton plant, prepared essentially as described by Viehœver, Chernoff, and Johns, and containing all of the odorous and volatile constituents of the plant, is reported from the Bureau of Chemistry, U.S.D.A. The individual substances isolated are summarized as follows: Methyl alcohol in large amount, with traces of acetone; amyl alcohol in relatively small amount, together with small amounts of higher homologues; acetaldehyde and traces of an aldehyde of higher carbon content; a very small amount of vanillin; traces of a phenol similar in its properties to *m*-cresol; an optically inactive dicyclic sesquiterpene, and a new optically active tricyclic sesquiterpene; a small amount of a paraffin hydrocarbon melting at 62° C., and thought to be triacontane, $C_{30}H_{62}$; a blue oil, probably containing the highly unsaturated hydrocarbon, azulene, $C_{15}H_{18}$; formic, acetic, and caproic acids; and ammonia and trimethylamine in appreciable amounts.

128. COTTON HAIR AND CELLULOSE ACETATE: HYGROSCOPICITY. By A. Caille (*Chem. Abs.*, 1925, **19**, 1498. Abstr. in *J. Text. Inst.*, xvii., **9**, 1926, A. 281.)

129. THE IMPORTANCE OF HAIR WEIGHT PER CENTIMETRE AS A MEASURABLE CHARACTER OF COTTON AND SOME INDICATIONS OF ITS PRACTICAL UTILITY. By W. E. Morton. (*Shirley Inst. Memoirs*, vol. v., September, 1926.)

Cf. Summers, p. 25, in this issue.

130. THE MICROSCOPICAL EXAMINATION OF DAMAGED COTTON HAIRS BY THE CONGO RED TEST, AND THE SWELLING TEST OF FLEMING AND THAYSEN. By T. B. Bright. (*Shirley Inst. Memoirs*, vol. v., July, 1926.)

Cf. Summers, p. 26, in this issue.

131. COTTONSEED LINT: ESTIMATION. By T. L. Rettger. (*J. Oil and Fat. Ind.*, 1926, **3**, 135-6. Abstr. in *J. Text. Inst.*, xvii., **9**, 1926, A. 283.)

132. AN EXPERIMENTAL METHOD FOR INVESTIGATING THE THERMAL PROPERTIES OF COTTON FABRICS. By J. Gregory. (*Shirley Inst. Memoirs*, vol. v., September, 1926.)

133. COTTONSEED OIL. DISAPPEARANCE DURING GERMINATION. By E. E. Randolph. (*Bot. Abs.*, 1926, **15**, 810. Abstr. from *Summ. Curr. Lit.*, vi., **16**, 1926, A. 43.) When sound cotton seed is germinated, the oil content (including both seed and seedling) drops from 19·5 to 16·75 per cent. during the first three days. In the next three days the drop continues to 7·5 per cent. About this time the seedling breaks through the seed coat. On the fifteenth day the oil is practically gone. In the usual slight warehouse heating, the oil content does not drop appreciably if the seed can be worked whilst still damp. If allowed to dry the loss is considerable.

134. COTTONSEED: ANALYSIS. (*J. Oil and Fat. Ind.*, 1926, **3**, 34-6. Abstr. in *J. Text. Inst.*, xvii., **9**, 1926, A. 283.)

135. COTTONSEED OIL. UNITED STATES. (Abstr. from *Int. Cott. Bull.*, vol. v., **17**, 1926, p. 114.) A record-breaking domestic consumption of cottonseed oil products during the crop year just ended not only cleared the market of a heavy carry-over from the previous season, but also lifted the weight of the year's enormous supply of oil. Only moderate quantities have been carried forward into the new year, sufficient, however, to supply prospective requirements until the new crop of seed, which again promises to be large, comes on the market in quantity.

The heavy consumption of the 1925-26 season found reflection in sweeping price changes. From a level of less than 10 cents a pound last fall, it rose in the early summer of 1926 to levels not seen since 1920. Early in June refined oil sold above 16 cents, and while this level was not maintained until the close of the season, prices were fluctuating about a 15-cent level. Since then,

partly under the influence of a large prospective cotton crop, and partly because of weakening lard prices, cottonseed oil has declined to around 13 cents a pound.

Before the war the quantity of seed crushed averaged 4,300,000 tons a year, or roughly three-quarters of the seed produced. During the war period the average rose to 4,700,000 tons, reflecting rather a greater percentage of seed crushed under the stress of war demand than an increase in seed production. The highest figure ever reached, 5,800,000 tons, was attained in the crop year 1915. After the war, the short crops of the cotton years ending July 31, 1922, 1923, and 1924, curtailed the quantities of seed available; in 1921-22 only 3,000,000 tons were crushed. Insufficient supplies of seed to keep the mills working, coupled with low prices for oil, demoralized the industry. Prior to the war, the United States exported great quantities of oil to Europe, but now it is mainly consumed in the country.

136. COTTONSEED OIL. MANUFACTURE. By C. E. Rose. (*Mech. Eng.*, 1926, **48**, 740-2. Abstr. from *Summ. Curr. Lit.*, vi., **16**, 1926, B. 94.) Some data are given of the steam plant and power equipment of the Dixie Cotton Oil Co.'s mill at Memphis. The mill is the largest in the world, and crushes 400 tons of seed per day of twenty-four hours. The sequence of crushing processes is outlined.

137. COTTONSEED OIL. OXIDATION. By N. G. Chatterji and G I. Finch. (*J. Soc. Chem. Ind.*, 1926, **45**, Abstr. in *Summ. Curr. Lit.*, vol. vi., **18**, 1926, B. 109.)

138. COTTONSEED GOSSYPOL: PROPERTIES. By F. W. Sherwood. (*J. Agr. Res.*, 1926, **32**. Abstr. from *J. Text. Inst.*, xvii., **9**, 1926, A. 292.) Brief notes are given describing the cooking of cotton seed preparatory to making cottonseed meal. The content of gossypol and *d*-gossypol in forty samples of N. Carolina cottonseed meal is reported, and it is shown that about 75 per cent. of the gossypol originally in the cotton seed is converted into the less toxic *d*-gossypol on cooking.

139. THE PREPARATION OF RAFFINOSE FROM COTTONSEED MEAL. By D. T. Englis, *et al.* (Abstr. in *Exp. Sta. Rec.*, vol. liv., **9**, 1926, p. 804.)

MISCELLANEOUS.

140. BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION. From the Report of the Seventh Ann. Gen. Mtg., held on September 14, 1926, we quote the following: "Our co-operation with the Empire Cotton Growing Corporation, which includes, amongst other things, the spinning of and pronouncing on the merits of various Empire cottons, has been made more comprehensive. We are now receiving cotton experts from the Colonies at the Shirley Institute. These visitors stay for two or three weeks, and last year they included representatives from India, Uganda, Nigeria, Tanganyika, Egypt, and Australia. They are given the benefit of our knowledge on the measurements and properties of cotton which most interest them. They are also entertained at members' mills, and they undoubtedly find the visits of great value. Eight Empire Cotton Growing Corporation students have also this summer been given the usual fortnight's instruction before being sent abroad. It is also noteworthy that there is a marked increase in the number of technologists and research workers from within the industry who take advantage of any facilities of coming to the Institute for assistance and training in special points of technique."

141. SKINNER'S COTTON TRADE DIRECTORY OF THE WORLD. 1926-7. (London and Manchester, 1926, 30s. net.) The enormous bulk and weight of this volume, which runs to 2,312 pages quarto, lead one to expect that there will be few facts relating to the trade that are not included, and indeed this is so. The tags

by whose aid one finds the sections are labelled, Index to Advertisers, Cotton Exporters, Cotton Merchants and Brokers, Cotton Waste, Spinners and Manufacturers, Directors, Managers; Great Britain, United States, Germany, France, Italy, Other Countries; Yarn; Doublers, Finishers, Merchants, etc.; Piece Goods; Finishers, Merchants, etc.; Fabrics, Artificial Silk, Mill Supplies; Textile Machinery and Accessories; Electrical; Chemical. From these headings the contents of the book may be inferred, and it remains only to say that the information under every head is given in the most careful detail, with addresses, titles of firms, capital, number of spindles, list of manufacturers of every kind of fabric, and so on. No one who has occasion ever to desire to know where to apply for any service, any fabric, or other item that has any connection with cotton, need go beyond this book to find what he requires, and the book will be indispensable to all engaged in any way in the cotton trade.

142. COTTON AND ITS PRODUCTION. By W. H. Johnson, formerly Director of Agriculture, Gold Coast, with introduction by Sir Wyndham Dunstan, K.C.M.G., F.R.S., and foreword by Sir William Himbury. London (Macmillan and Co.), 1926.

This is a stout volume of 532 pages, and deals in some detail with its subject. It should be very useful to students in this country, and to those abroad who want a general work of reference which will give them the information they may require as to what is being done in other countries. Commencing with an historical and botanical account, a full account, with useful maps in which the cotton areas are roughly outlined in green, is given of cotton production in the United States, India, Egypt, Brazil, China, Russia, the British Empire, and minor countries. Chapter XI. goes on to the cultivation of cotton in general, and in following chapters, Handling, Marketing, Improvement, Diseases, Pests and By-Products are treated. The work ends with a useful bibliography.

143. LIVERPOOL COTTON ANNUAL. This is the first issue of this publication, and contains, among others, interesting articles by Mr. Bryce Muir, "What are 'Cotton Futures'?" Mr. A. C. Nickson, "Liverpool and the Cotton Trade," and Professor J. A. Todd, "Cotton Statistics."

144. WEST INDIES. IMPERIAL COLLEGE OF TROPICAL AGRICULTURE. (Abstr. from *West India Committee Circular*, xli., **734**, 1926, p. 444.) At a luncheon given by the Governing Body to the Dominion Prime Ministers and representatives at the Carlton Hotel on November 12, Mr. Amery announced that the King had approved the grant of a Royal Charter of Incorporation to the Imperial College of Tropical Agriculture. He further stated that with contributions from His Majesty's Government, the Empire Marketing Board, and the Lancashire cotton industry, Lord Milner's fund of £100,000 was now almost complete.

145. THE HERITAGE OF COTTON: THE FIBRE OF TWO WORLDS AND MANY AGES. Price 21s. By M. D. C. Crawford. (New York and London: G. P. Putnam's Sons. Abstr. from *Bull. of Imp. Inst.*, xxiii., **4**, 1925, p. 528.)

146. RESEARCH AND MILL PERSONNEL. By Dr. J. C. Withers. (*Journ. of Text. Inst.*, xvii., **1**, 1926, p. 1.)

147. COTTON MILL MACHINERY MANAGEMENT: MULE SPINNING. By L. J. Mills. (*Text. Recorder*, 1926, vol. xliii., **516**, p. 46; vol. xliv., **518**, p. 46.)

148. COTTON MILL. MECHANICAL SUPERVISION. By S. S. Paine. (*Mech. Eng.*, 1926, **48**. Abstr. in *J. Text. Inst.*, xvii., **9**, 1926, A. 287.)

149. THE COTTON TRADE SITUATION. By Sir Percy Woodhouse, President of the Manchester Chamber of Commerce. (*Text. Rec.*, xliv., **521**, 1926, p. 105.)

150. THE SCOPE AND ORGANIZATION OF MANCHESTER TRADE. By Sir Percy Woodhouse. (*Manch. Guard. Coml.* Civic Week No., October 2, 1926, p. 33.)

PERSONAL NOTES

It is with much regret that we have to announce the death of Lord Emmott, which occurred suddenly at his residence in London on December 13. Lord Emmott was elected a Vice-President of the Council of Corporation at its inception in 1921, and his loss will be greatly felt.

We also have to announce with much regret the death, early in November, of Mr. H. P. M. Rae. Mr. Rae represented the Bombay Chamber of Commerce on the Council of the Corporation, and was a member of the India Sub-Committee.

APPOINTMENTS

Northern Rhodesia.

Mr. T. McEwen, Senior Assistant in Nyasaland, has been seconded for service under the Northern Rhodesian Government.

Nyasaland.

Mr. J. V. Lochrie has been appointed as an Assistant to Mr. Ducker in Nyasaland.

Sudan.

Mr. R. Peto has been appointed as Assistant Soil Chemist.

West Indies.

The Corporation have agreed to the appointment of Mr. G. Evans, C.I.E., as Acting Principal of the Imperial College of Tropical Agriculture during the absence of Dr. H. Martin Leake on sick leave.

STUDENTSHIPS.

The holders of Senior Studentships last year have obtained appointments as follows: Mr. E. R. Guest, Agricultural Inspector under the Sudan Plantations Syndicate; Mr. S. R. de Villiers and Mr. C. F. van Rooyen, Department of Agriculture, Union of South Africa; Mr. J. C. Haigh, Assistant Mycologist, Department of Agriculture, Ceylon; Mr. J. C. Lochrie, Assistant to the Corporation's Cotton Specialist, Nyasaland. Mr. F E. Kenchington's Studentship has been renewed for a further year; he is working under the Corporation's Plant Breeder in the Sudan.

OFFICERS ON LEAVE

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes "home" on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the

opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would call at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite to the offices of the Crown Agents for the Colonies.

At the date of writing the following officers are on leave in England from cotton-growing countries:

Gold Coast	Captain R. Coull.
,, ,, ...	Mr. A. B. Culham.
,, ,, ...	Mr. J. M. Dunbar.
,, ,, ...	Mr. G. H. Eady.
Kenya Colony	Mr. J. MacDonald.
Nigeria.	Mr. W. B. Dowson.
Nyasaland	Mr. F. Barker.
,, ...	Mr. E. W. Davy.
Rhodesia (Northern)	Mr. G. Walton.
Sierra Leone	Mr. D. C. Edwards.
,, ,, ...	Mr. E. J. Nisbett.
,, ,, ...	Mr. D. W. Scotland.
Tanganyika Territory	Mr. A. E. Haarer.
,, ,, . ..	Mr. E. O. Whitehead.
Uganda	Mr. G. W. Nye.

PRINTED IN GREAT BRITAIN BY
BILLING AND SONS, LTD., GUILDFORD AND ESHER

THE
EMPIRE COTTON GROWING
REVIEW

VOL. IV. APRIL, 1927. NO. 2

RECENT PROGRESS IN COTTON-GROWING IN INDIA

BY

B. C. BURT,

Secretary, Indian Central Cotton Committee.

It is only natural that the recent enhancement in the supply of American cotton should lead to less interest being shown, for the time being, in Empire cottons capable of replacing American. Nevertheless, since it is by no means likely that the enhanced American supply will be maintained, or that all anxiety about the world's cotton supply is over, it is as well to take stock of the present position as regards other supplies. Especially is this the case where India is concerned, not only because India is easily the second largest cotton producer in the world, but because certain very definite changes in Indian cotton production have taken place which appear to be of a permanent or a semi-permanent nature.

The steady increase in Indian cotton production since the war is remarkable. The estimated production figures, as given in the annual final cotton memorandum published by the Director-General of Commercial Intelligence and Statistics, for the last five years are as follows:

In bales of 400 lbs. each.

1921-22	4,485,000
1922-23	5,073,000
1923-24	5,161,000
1924-25	6,088,000
1925-26	6,038,000

At the time of writing no estimate of the 1926-27 crop is possible, for cotton-sowing extends from May to November in different parts of India.

The figures for the exports plus local mill consumption give the following totals for the commercial crop for the last five years:

In bales of 400 lbs. each.

1921-22	5,329,000
1922-23	5,582,000
1923-24	5,286,000
1924-25	6,173,000
1925-26	5,758,000

The latter, however, requires correction to allow for variation of internal stocks. For up-country stocks no figures are obtainable, but actual census figures for stocks in Bombay published by the East India Cotton Association on August 31 are available, and are as follows:

August 31, 1921	1,212,000 bales
,, ,, 1922	988,000 ,,
,, ,, 1923	692,000 ,,
,, ,, 1924	512,000 ,,
,, ,, 1925	373,000 ,,
,, ,, 1926	427,000 ,,

It is probable, due regard being given to the way in which cotton is financed and sold, that up-country stocks except those held by mills do not vary greatly except in very abnormal years. Mill stocks are not completely reported, but on the basis of those collected by the Bombay Millowners Association mill stocks* *outside Bombay Island* on the above dates may be taken as follows:

July 31, 1921	586,000 bales
,, ,, 1922	357,000 ,,
,, ,, 1923	331,000 ,,
,, ,, 1924	506,000 ,,
,, ,, 1925	448,000 ,,
,, ,, 1926	438,000 ,,

Applying this correction the *commercial* Indian cotton crop for the years under review would be:

1921-22	4,894,000 bales
1922-23	5,240,000 ,,
1923-24	5,281,000 ,,
1924-25	5,976,000 ,,
1925-26	5,802,000 ,,

To compare these figures with the final estimate of production issued by the Department of Commercial Intelligence and Statistics, a figure should be added for domestic consumption for other than mill purposes. Such consumption not only includes hand spinning, but, what is more important, all purposes other than spinning, such as the padding of the quilted coats, etc., so largely used in Northern

* Mill stocks in Bombay mills are included in the East India Cotton Association's annual census of Bombay cotton stocks.

India. The conventional figure adopted at present is 750,000 bales per annum, but there is grave doubt as to whether this is anywhere near the truth; no means exist for verifying it, but for our present purposes we can ignore it. The main conclusion from the figures presented is that the Indian cotton crop, instead of fluctuating in the neighbourhood of 4 million bales, now approaches closely to 6 million bales. How far that figure will be maintained on a lower range of prices is largely a speculative question, but two factors of importance may be mentioned. The increase has come partly through the development of new cotton-growing areas, which represent a permanent addition to Indian cotton production, and secondly, there has been a steady increase in the average yield per acre which, for a variety of reasons, seems likely to be maintained.

But more important perhaps than the increase in total production is the change in the composition of the crop. In 1915-18 India produced 4,160,000 bales of cotton per annum, of which 2,999,000 was short staple cotton and the remaining 1,161,000 bales cotton of medium staple; now the figures are: short stapled, 3,893,000 bales, and medium stapled, 2,145,000 bales. The staple of Indian cottons ranges from $\frac{1}{2}$ to $1\frac{1}{8}$ inches, with a small quantity barely touching $1\frac{3}{16}$ inches, and it is not easy to find a dividing line between short and medium staples. At one end of the scale the $\frac{1}{2}$ to $\frac{5}{8}$ inch cottons, typified by Bengals and Oomras, are easily enough recognized; at the other end of the scale the best Surats, Punjab-American, Cambodia, and other growths with a staple of a "commercial inch" and upwards are characteristic enough, but between these limits there is a considerable supply of $\frac{3}{4}$ to $\frac{7}{8}$ inch cotton such as Dholleras which, though of short staple according to Liverpool ideas, is yet of considerable importance to spinners in India and the East. Hence any attempt at classifying the Indian crop must be in the nature of an approximation, and the table on p. 96 is only put forward as a tentative effort to indicate what portion of the Indian crop merely meets the special demand for short-stapled cottons, and what portion is a definite addition to the world's supply of medium-stapled cottons.

For obvious reasons the estimate of the long staple class is a conservative one, and does not take into consideration the fact that $\frac{3}{4}$-inch cottons can be, and are, used in some countries in yarns for which in others the cheaper styles of American cotton are used, or of the certainty that in years when the American crop is short a certain amount of substitution takes place.

Nevertheless, the table shows that India now contributes 2 million

PROGRESS OF THE INDIAN COTTON CROP, 1915 TO 1926, BY VARIETIES AND LENGTH OF STAPLE.

Varieties.	*Average during* 1915-18 *in* '000 *Bales.*	*Estimated crop during* 1924-25 *in* '000 *Bales.*	*Estimated crop during* 1925-26 *in* '000 *Bales.*	1925-26 *per Cent. Increase over* 1915-18.
Short Staple:				
Oomras (excluding Hyderabad Gaorani)	1,631	1,970	1,926	—
Dholleras	472	606	626	—
Broach (part)	93	97	110	—
Bengals	687*	1,042	1,050	—
Comillahs, Burmahs, etc.	79	112	124	—
Coconadas	37	54	57	—
Total short staple (below ⅞ in.)	2,999	3,881	3,893	29·8
Long Staple:				
Oomras-Hyderabad Gaorani (Bani)	168	450	550	—
Broach (part)—Surat-Navsari mostly 1027 A.L.F. (staple 1 inch)† ..	—	122	127	—
Broach (others)	190	114	87	—
Kumpta-Dharwar—Gadag No. 1 (staple 1 inch)†	—	15	21	—
Kumpta-Dharwar—Dharwar No. 1 (staple ⅞ inch)†	—	20	30	—
Kumpta-Dharwar—other Kumpta and Dharwar American ..	282	308	263	—
Westerns and Northerns—Nandyal 14 (staple 15/16 to 1 inch)‡	—	3	3	—
Westerns and Northerns—Hagari 25 (staple ⅞ inch)§	—	6	25	—
Westerns and Northerns (others) ..	193	345	345	—
Tinnevellys, including Karunganni—Karunganni (staple ⅞ inch) ..	40	60	60	—
Tinnevellys, including Karunganni—other Tinnevellys	66	97	106	—
Salems and Cambodia—Irrigated Cambodia (staple 1 to 1⅛ inch) ..	101‖	139	113	—
Salems and Cambodia—other Cambodia and Salems	78‖	69	85	—
Punjab and Sind Americans (staple 15/16 to 1⅛ inch)	43	359	330¶	—
Total long staple	1,161	2,107	2,145	84·8
Grand total	4,160	5,988	6,038	45·1

* Average for five years ending 1914-15.

† Staple greatly improved as a result of the Cotton Transport Act, and now far more uniform.

‡ Previously also known as "Sircar 14."

§ Previously also known as "Sircar 25."

‖ Average for 1916-18. Revised figures reported by D. A. Madras.

¶ The figure adopted is that given in the supplementary cotton forecast, April, 1926. The returns from cotton-pressing factories, however, indicate that the crop is considerably above the estimate, and probably exceeds 400,000 bales.

bales of cotton of staple suitable for replacing American for many purposes, and instead of having only a nominal margin of such cottons for export, now has an appreciable exportable surplus, after providing for the needs of her own mills.

Not all Indian staple cottons are suitable for export to Great Britain, for several reasons. In the first place, certain cottons, of which *Kumpta* and Hyderabad *Gaorani* may be quoted as examples, have a high refraction due to the presence of considerable quantities of leaf, which renders them unsuitable for use in mills laid out for American cotton. Others, again, cannot freely be substituted for American on account of a difference in colour. Indian and other Eastern mills are laid out with large "blow rooms" capable of handling leafy cottons to advantage, and it seems likely that cottons of the type referred to above will continue to be used mainly in such mills, and that export will be limited chiefly to those types more nearly resembling American in general characteristics.

A similar reason explains the recent substantial importation into India of low-grade American cotton.* Such importations have taken place spasmodically for the past thirty years, averaging over that period some 25,000 bales per annum, imports in individual years ranging from nil to 100,000 bales, but commonly lying at about 5,000 to 10,000 bales. There is nothing paradoxical in a great cotton exporting country, whose mills consume 2 million bales per annum, importing small amounts of this nature for special purposes, and a parallel is to be found in the U.S.A. imports of Egyptian and Indian cottons. But it would seem that such imports have largely been induced by the fact that low-grade American cotton has been cheaper than certain of the better-class Indian cottons, which it can replace in those mills which have the necessary cleaning machinery.

The Newer Indian Cottons.

It is of interest to note in what ways this expansion of the Indian stapled cotton crop has taken place. Three processes have been at work. Firstly, an increase in the area under cotton has occurred in the older staple cotton tracts. Thus the area under the various cottons included under the general term "Broach" has increased from 1,036,000 acres in 1915 to 1,387,000 acres in 1925. The total area of cotton in the Madras Presidency, practically all of which comes under the definition of medium-stapled cotton, has increased from 2,188,000 acres to 2,791,000 acres in the same period.

* About 44,000 bales from December, 1925, to October, 1926.

Secondly, the application of the Cotton Transport Act and other measures, including the organization of seed supply on a large scale. has led to the exclusion of inferior cottons from existing good staple tracts. Here the improvement has been in quality, purity, and regularity, and is less easy to express in figures, but is none the less important.

Thirdly, we have the systematic introduction of improved varieties, a process which has been going on for several years. Here, again, two methods have been employed. In the older long-staple cotton tracts properly controlled selection work followed by a thorough organization of the supply of seed has led to very considerable development. In Madras the old mixed Tinnevelly crop, a mixture of *Karunganni* and *Uppam* types (*i.e.*, of *G. indicum*, *G. herbaceum*, and of various hybrids) has been replaced to a very great extent by the Karunganni type; indeed, the area under Karunganni cotton is now believed to approach 300,000 acres. Further, the original " bulk " Karunganni is now being steadily replaced in turn by a later selection of still greater regularity, the Company type of Karunganni, of which the production is now placed at 40,000 bales.

In the Surat cotton tract of the Bombay Presidency, and in adjoining Indian State territory, an area of some 500,000 acres has been practically cleared of shorter-stapled intruders, whilst the pure line selection 1027 A.L.F., a cotton of $1\frac{1}{16}$ to $1\frac{1}{8}$ inches staple, is being steadily pushed throughout the tract. The production of the pure strain from controlled seed has reached 50,000 bales, but this does not represent the whole of the progress made, for it is believed that within two or three years practically the whole of this large tract will be growing one improved strain of cotton. Similar work is going on in the Kumpta Dharwar tract, and the pure line selections Gadag No. 1 (improved Dharwar Upland) and Dharwar No. 1 (improved Kumpta) now cover 97,000 acres and 120,000 acres respectively, with an estimated production of some 21,000 bales and 30,000 bales respectively. Mention should also be made of the improvement which has taken place in recent years in the Hyderabad cotton crop by the re-establishing of the old Bani (Gaorani) type on something like a million acres, and the exclusion of the short-staple Oomras type.

Next we come to the definite introduction of medium-stapled cotton in new areas, and the replacement of short-staple by long-staple cottons; this amounts to the history of the introduction of American cotton mainly with the aid of irrigation. Since the mis-

statement that the introduction of American cotton into India has been a failure has been repeated in a very recent publication on cotton-growing, it is desirable to emphasize the fact that the two most outstanding instances of the successful introduction of a medium staple cotton into general cultivation in a new tract are Cambodia and Punjab-American—both cottons of the American as distinct from the Asiatic type. The former is grown on an area of 416,000 acres producing 164,000 bales, the latter on 1,066,000 acres producing 328,000 bales.

There have been the usual legends about steady deterioration, none of which have any substantial foundation. Difficulty there has been, due to deliberate mixing with inferior cotton in the ginneries—an abuse which recent legislation should do much to stop. It is true that *unirrigated* Cambodia cotton is inferior to the irrigated crop in quality, but Cambodia cotton in Madras is essentially an irrigated cotton grown with intensive cultivation. In 1925-26 the area of irrigated Cambodia cotton was 184,000 acres, and the yield 113,000 bales. It is also a fact that some Punjab-American, mainly that grown on unsuitable land or with inadequate irrigation, has been poor in quality, and that the yields from the present strains have not been satisfactory in unfavourable seasons such as 1920 and 1921. But, broadly speaking, we have in these two varieties two important sources of supply of extremely useful cotton. The success of American cotton in the Canal Colonies of the Punjab is an excellent augury for the development of a great staple-cotton tract in Sind on the completion of the Sukkur Barrage Canal system.

In two recent numbers of the *Empire Cotton Growing Review* have appeared the results of spinning tests, conducted with the co-operation of the Oldham Master Cotton Spinners Federation, the British Cotton Growing Association and the Empire Cotton Growing Corporation, on certain improved Indian cottons. These tests were originally proposed by the Indian Sub-Committee of the Corporation, and were carried out with the object of demonstrating under commercial conditions how far certain Indian cottons were capable of replacing American cotton under standard Lancashire conditions. The results of two years' tests may be summed up as follows:

The best Punjab-American, Madras Cambodia, Surat 1,027 A.L.F., are definitely suitable for use in Lancashire mills, and the same applies to the improved Dharwar Upland (Gadag No. 1). The improved Madras Northerns and Westerns cottons, Sircar (now Nandyal) 14 and Sircar (now Hagari) 25 are also suitable for use in Lancashire, but are more likely to appeal to those mills which are

already using Indian cotton. Karunganni is likely to appeal mainly to those mills which already use Tinnevelly cottons. Dharwar No. 1, the improved type of Kumpta, at present would seem to be too leafy for mills laid out for American cotton.

The prices which these new Indian cottons will command naturally will largely be governed by American prices, and will depend partly on the character of the ginning. Hence the recent marked development of saw ginning in the Punjab is of particular interest.

Comparative spinning tests at the Indian Central Cotton Committee's Technological Laboratory on 289F (the longest staple strain of Punjab-American at present cultivated on any considerable scale) have shown that the saw-ginned cotton was not only cleaner than roller-ginned cotton from the same batch of *kapas*, but was less neppy and produced a better yarn. Whether saw ginning is suitable for the general run of Indian cottons of the Asiatic type, and whether the general introduction of this method of ginning is either feasible or desirable, is too wide a question to be discussed in this article. What is perhaps of immediate interest is that an adequate supply of saw-ginned Punjab-American cotton is likely to be available in the immediate future for those spinners who prefer it.

To prevent future misunderstanding, it is perhaps desirable to refer here to a curious anomaly which has come to the writer's notice. It seems that a type of cotton described as "Surat-American," and sold apparently as a saw-ginned cotton, is being supplied in considerable quantities by a well-known firm of exporters from India. Not only is no such cotton recognized in Bombay, but no American seed cotton is grown in Surat, and no Surat cotton is saw-ginned at present. On the other hand, Surat now produces the very useful long-staple cotton known as Surat 1027 A.L.F. by the Agricultural Department and as Surat "Farm" cotton by the cotton trade in Bombay; Surat 1027 has a staple of $1\frac{1}{16}$ to $1\frac{1}{8}$ inches, and hence may be said to be of "American" staple. What actually has been supplied against this private "Surat American" type is a little doubtful. One sample supplied in 1924 appeared to be Punjab-American 285F. What has been supplied since appears to be a (saw-ginned) cotton of American type and of $\frac{15}{16}$ to 1 inch staple, and very probably was good Punjab 4F. It is extremely desirable that there should be no misdescriptions of this kind in future. The term "Surat" should be strictly reserved for cotton grown in the Surat cotton tract; the word "American" should never be included in the description of an Indian cotton unless the cotton is grown from the American type of seed. The Cotton Ginning and Pressing

Factories Act now in force throughout British India (excluding Burma), and in a number of Indian States, requires all bales to carry on the central hoop the mark allotted to the pressing factory in which the bale is pressed. The prescribed marks for all presses in Surat District include the index letter "B" (Bombay Presidency), and similarly all Punjab press marks include the letter "P," and Sind press marks the letter "S." A complete list of press marks and the text of the Act and Rules will be found in recent numbers of the *International Cotton Bulletin,* and buyers are consequently in a position to establish the origin of the cotton delivered to them.

Mention has been made above of the plant-breeding work which has resulted in the production of the new cottons referred to, but it is desirable to explain that this represents only a tithe of the work in progress, much of which is now reaching the stage where its effect on the character of the Indian cotton crop will be felt. What may perhaps be described, for want of a better term, as a geneticist's survey of the Indian cottons, is now in progress in practically every cotton-growing tract of importance. Improved types of Broach, Dholleras, Madras herbaceums, and Oomras cottons have now reached, or are reaching, the field-test and spinning-test stage, whilst in tracts where improved types are already in cultivation a further detailed study of the various races contained in the local varieties is being made.

Attempts are also being made, and with some promise of success, to reach by hybridization a degree of improvement not attainable by other means, and should the early promise of such work be fulfilled important further steps in the replacement of short-stapled by medium-stapled varieties of cotton will be possible. Nor have the limits of "pure line" selection been reached in many cases, and particularly is this true of the acclimatized American cottons.

The work which has been started on the physiological aspect of cotton-growing at various places should also throw considerable light on a number of factors affecting both yield and quality which are at present little understood. The development of the work of the Indian Central Cotton Committee's Technological Laboratory at Bombay not only provides for a precise determination of the possibilities of a new cotton, but considerably simplifies the work of the cotton breeder, and we trust will do more in this direction as time goes on.

From the agricultural point of view the prospects of further improvement in the quality of Indian cottons are bright. There is, however, the risk of a set-back from commercial and economic causes.

The problem which faces the agricultural officer at present is whether the necessary margin between the prices of short-staple and medium-staple Indian cottons will be maintained now that the supply o American cotton, temporarily at any rate, is more than adequate. Since a large proportion of the world's spindles are designed for a staple of $\frac{7}{8}$ to $1\frac{1}{8}$ inches, the demand for the hardy short-stapled Indian cottons (*i.e.*, cottons of $\frac{1}{2}$ to $\frac{5}{8}$ inch staple) is probably not capable of any rapid expansion. On the other hand, such demand is comparatively constant, and there would seem to be indications that the price margin referred to above will narrow. Hence it is of importance that Indian staple cottons should not lose their footing in any market where they are now known. At the time of writing, the disparity between Indian and American prices, which for a time made business almost impossible, shows signs of disappearing. Spinners who have been favourably impressed with the possibilities of Indian cottons for permanent use might with advantage consider whether they would not be protecting themselves against the next shortage of American cotton, which would seem to be inevitable, however long deferred, by continuing to use Indian cottons.

Received December, 1926.

COTTON-GROWING IN CYPRUS

The island of Cyprus, which has an area of 3,584 square miles—*i.e.*, about twice the size of the county of Lancaster, or almost equal to Kent, Surrey, and Sussex combined—lies on the 35th parallel of north latitude, or level with the northern portion of the American cotton zone. Its population at the census of 1921 was 310,709, an increase of 12 per cent. on that of 1911, which was 275,000.

The climatic conditions are very favourable to the cultivation of cotton, the rains ceasing before the commencement of summer, so that the necessary dry and warm period for the ripening of the crop is generally to be relied upon. The rainfall is low, rarely exceeding 20 inches in most of the island, but as it falls during the winter, it is better able to soak into the soil. Irrigation from streams or from storage tanks appears to be practicable only to a very slight degree, but experiments are in progress to determine to what extent subsoil water may be utilized.

Most of the soils of the island are suitable to the cultivation of cotton, and they appear to be superior to those of Egypt. Both long and short staple cottons are doing very well, and when properly treated they produce fibre of excellent quality (*cf. Rep. Imp. Inst.*, June, 1926).

The average area under cotton during the last five seasons and the production were as follows:

Year.	*Area* (*Acres*).	*Production* (*Lbs. of Ginned Cotton*).	*Average* (*per Acre*).
1921-22	6,600	1,018,789	154
1922-23	5,700	601,798	105
1923-24	6,000	893,053	148
1924-25	10,600	1,358,933	128
1925-26	10,500	1,328,122	126

The largest production since the occupation of the island was in 1890, the first year of the abolition of the cotton taxation, when 22,222 cwts. of lint were obtained. It is clear that Cyprus offers a possibility of an appreciable increase in the cotton supply of the Empire. She has been known since ancient times as a producer of cotton, and between 1489 and 1570 exported about 75,000 cwts. a year, or considerably more than at present.

The area really suitable to cotton cultivation is about 50,000 acres, of which under present conditions about two-thirds are suited to " dry " cultivation on unirrigated land. The fields are flooded with water from the streams during the winter, and then ploughed,

so that the moisture is retained during the summer, the land being prepared for planting in the spring. The yield from " dry " cultivation is but small, averaging about 96 lbs. of lint a year. " Wet " cotton, grown under regular irrigation, on the other hand, gives very good returns indeed, the average being about 4 cwt. and 50 lbs., or practically a bale, to the acre. If it should prove practicable and economical to irrigate more land, it is clear that the production of the island might be greatly increased.

In former days Cyprus produced only one variety of cotton, the *Gossypium herbaceum.* This still exists in the Kyrenia district, where it is grown as a perennial with a life of about fifteen years. but it is now chiefly replaced by American varieties, some of which are doing very well, while Egyptian kinds are also under trial. The following varieties of cotton have been tried in Cyprus:

American : Triumph, Durango, Allen's Long Staple, Sea Island, Mebane, Culpepper, Big Boll, Griffin's Sunbeam, Simpkins, Peterkin, Fruitt's New Orleans, Webber, Brown, Hartsville, Acala, Lone Star.

Egyptian : Ashmouni, Sakellarides, Zagora, Pelion, Assili. and also the Caravonica tree cotton.

Although some of the long-staple varieties are doing very well, cultivators pay more attention to those of shorter staple, such as Triumph and Durango, which produce larger yields than the long-staple forms. Cotton is sold by quantity in Cyprus, and the quality is practically disregarded. None of the above-mentioned varieties have been kept pure, so that the cotton produced in the island is a mixture of all, Sea Island, Allen's, New Orleans, and Triumph predominating.

It is of special interest to note that the Egyptian cotton Sakellarides has given excellent results as compared with the other varieties. It matures somewhat later than the American varieties, and its production is slightly less, but the quality is excellent. The great difficulty in adopting or in advocating the cultivation of this form is that the merchants do not buy by quality, and consequently the cultivation of Sakel is not so profitable as that of varieties of less real value.

Grading of cotton is unknown in Cyprus, and if steps were taken to introduce it, there is no doubt that better prices would be obtained. Funds, however, are needed for its introduction, for providing better instruction to the growers, and for extension of irrigation, should this prove to be economically practicable.

C. NOBLE,
Director of Agriculture.

November, 1926.

COTTON-GROWING IN FIJI*

FIRST PROGRESS REPORT, SEASON 1925–26

RECEIVED FROM

R. R. ANSON

The Corporation's Cotton Specialist attached to the Fiji Government.

THE cotton-growing season for 1925-26 now being practically over, I am forwarding a report covering the period December, 1925, to December, 1926. In doing so I wish to make it fully understood that this report is based on personal impressions which have been gained during my short experience in the Colony; further experience may make it necessary for me to change many of my views, and many of the statements set down herein must be left open for correction.

On the recommendation of Mr. G. Evans, who made a thorough tour of the Fiji Islands during July and August of 1924, I was appointed by the Empire Cotton Growing Corporation, and attached to the Government of Fiji as Cotton Specialist, the primary object of my appointment being that of plant-breeding on cotton, with a view to raising new and improved types, together with testing new varieties, and for carrying out experiments on the cultivation of the crop. I arrived in the Colony during the latter part of November, 1925.

GENERAL.

As cotton planting was in full swing at the time of my arrival, it was too late in the season to attempt commencing work on an Experiment Station, and it was therefore decided that it would be advisable for me to make a thorough tour of the Islands, so that I should be in a position to select a suitable site for the Experiment Station.

The past season, though exceptionally dry at its commencement, will, I think, prove to be the best that this Colony has experienced productively since the re-establishment of the industry. Indian growers with small acreages averaging from one to four acres each are mostly responsible for the large average yield per acre which is anticipated. Having only small areas to plant, they were able to

* See also "Cotton-Growing Prospects in Fiji," by G. Evans, *E.C.G. Review*, vol. iii., p. 1.

take full advantage of the small showers which fell during December and January. The European growers of large areas were in most cases unable to complete their plantings until late in the season, thus lowering their average output per acre.

Transport and Communication.

The only railways in the Colony are those belonging to the Colonial Sugar Refining Company, which has refused to transport cotton on them, as it fears that the encouragement of cotton-growing in or near the sugar-cane areas would be contrary to its own interests. Although this fear may be only natural, personally I do not think that the Company would be affected to any great extent. At present the greatest proportion of the crop is produced by small holdings right at the back of the cane zone and four or five miles from the rail lines of the cane areas, and very few of the cotton-growers or members of their families have worked for the Company in any capacity for the last seven or eight years.

The interinsular communication consists of a weekly service to the most important ports on the eastern side of Viti Levu and Levuka on Ovalau, and a similar one runs between Nambouwalu and Lambasa on the Vanua Levu Island. Small auxiliary cutters averaging about twenty-five tons, captained by Fijians, and lacking in accommodation for passengers, ply between the less important island ports at such times as suit their owners best; very few of them run to scheduled times.

The Sigatoka district is particularly unfortunate in this respect; weather conditions sometimes prevent these small cutters from entering the mouth of the river (which is a treacherously narrow one surrounded by coral reef) for days at a time.

A road linking up with Momi Harbour, a distance of about twenty miles from the nearest point on the Sigatoka River, is therefore urgently needed; it might eventually be extended to the Nadi-Lautoka road, thus making it possible to motor from one end of the dry zone of Viti Levu to the other.

It will, therefore, be seen that there is room for great improvement in both transport and communication. The former will probably right itself if the industry grows and becomes an important one; even now three or four motor lorries have been put on the roads and are running between Ba and Lautoka and Nadi and Lautoka, principally for the purpose of conveying cotton to the ginnery. If they were given a little encouragement the Indians would themselves

most probably make branch tracks from the main roads to their various gemens, or holdings, suitable for motor traffic in dry weather. This has already been done in a rough sort of way by some of them; the remaining ones bring their cotton in sledges, on pack animals, or on their heads to the nearest point on the road, where it is picked up by motor lorries or carts and conveyed to the ginnery.

It has been suggested by the Cotton Inspector, Mr. B. L. Field, who is in charge of the ginning and baling, etc., that owing to the difficulty of organizing the arrivals of consignments of seed cotton from various centres to the ginnery at Lautoka, where there is only a limited space for the storage of seed cotton, it would be advisable to erect small seed cotton stores in which the cultivators could store their cotton at suitable centres along the main route in the cotton-growing zone, where the seed cotton would await arrangement for transportation to the Government collecting agents or to the cotton ginnery. These sheds might be erected by the Indian Cotton Growing Association, which might be able to collect the requisite funds for so doing from the cultivators. If this were done it would undoubtedly obviate congestion at the ginnery, which during the past season has been the cause of a considerable amount of inconvenience both to those in charge at the ginnery and to the cultivators, as owing to the lack of accommodation at the ginnery a number of arrivals on various occasions have had to be turned away, which has caused dissatisfaction to the growers, and no doubt has put them to extra expense.

Experiment Station.

Having made a thorough tour of the Islands, I decided that the most suitable district in which to put the Experiment Station would be that of Sigatoka, my reasons being that I considered the soil to be the most suitable, and more uniform than that of any other district, and that the largest consolidated area of suitable cotton-producing country was to be found there, and also, though it possesses no roads worthy of mention, it has a river by which it is possible for the natives to convey their seed cotton to the ginnery district.

I tried to obtain a site as close to the Government Station as possible, so that little time would be wasted in proceeding to and from the farm, but owing to the difficulty experienced in obtaining land of any description, I was forced to put the main farm five miles up the river at Nococolevu, which, with the exception of the precipitous and dangerous road which leads to it, is quite a suitable site and easily accessible by river.

The land consists of a moderately rich "Bila" composed of a friable, light, loamy river silt, fairly high and well drained, bounded on one side by a creek. The total area is twenty-seven acres. This can, if necessary, be increased up to seventy-five acres, as occasion demands.

Buildings.—The following buildings, all of which are constructed of galvanized corrugated iron, have been erected: (1) Office, cotton store, and junior assistant's room, all under one roof; (2) men's quarters capable of housing four labourers; (3) four-stalled stables and tractor shed under one roof; (4) implement shed; (5) petrol store.

Clearing was commenced on September 3. This was rather tedious and expensive, as there were a good many trees and large guava to be grubbed out. The land received its first ploughing on September 28, and planting was commenced on November 18.

The following varieties were planted out in duplicated ½-acre plots: (1) Sea Island; (2) Meade; (3) Kidney; (4) Pima; (5) Hybrid (probably a Sea Island and Kidney cross). With the exception of Pima, which failed to germinate, although it was resown twice, the germination was very good. The Pima plots were eventually sown with Meade, and as a check against soil variation, one acre divided into $\frac{1}{20}$-acre plots was planted with all the above varieties set out on the "chessboard" system. similar to that shown by Messrs. F. L. Engledow and G. Udny Yule in their article on "The Principles and Practice of Yield Trials." Here again the Pima failed to germinate, and had to be replaced by Meade.

The seed of one complete series of experiments on the station was treated with "Izal" in the proportion of 1 in 250, the remaining series being sown with untreated seed. This was done with a view to ascertaining the merits or otherwise of "Izal" as a control for Black Arm and Angular Leaf-spot.

Time of planting and spacing and thinning tests have also been set out in ¼-acre plots, some of which have been planted with Sea Island. In addition to the above, lines of single-plant selections, duplicates of those planted in isolated plots at Koromumu and Lawaga, have been set out as a check against the latter, which have been planted on soils varying slightly from the average type of cotton soil in the district, and one line of Acala cotton has been set out for purposes of observation. Five acres of Meade will be planted this week, providing that the weather conditions remain favourable. Three or four acres have been planted with maize for fodder purposes.

Seed Selection and Cotton Breeding.

One hundred selections of Sea Island seed were made altogether; these were eventually cut down to fourteen, and planted out in lines on an isolated plot at Koromumu; particulars are given on p. 110. Details regarding the Meade, Korolevu Hybrid and Lautoka Kidney varieties are given on p. 111.

In addition the following selections made by Mr. Evans when in New Guinea, viz., K.1, K.3, K.8, K.11, and K.24, were planted out in lines 7 feet by 5 feet 6 inches on an isolated plot at Lawaga school. These have all germinated well and are making a rapid and succulent growth; they are therefore found to be particularly palatable to the "Tip Worm" (*Earias fabia*). I shall attempt to control this attack by dusting the terminals with calcium or lead arsenate if either is obtainable in Suva.

A full report on the field characters of the above selections, together with samples, will be forwarded to the Empire Cotton Growing Corporation at the end of this season. Duplicate lines of these selections have been planted out at the main farm at Nococolevu in order that their field characters may be observed on a different type of soil. Here again the plants have all germinated well, and are now making vigorous and rapid growth; at present they are 3 feet high and have been in the ground for fifty-three days.

Field Work.

Most of the growers who are situated in accessible places were visited either once or twice during the season, but owing to the lack of roads, Government rest-houses, or dâk bungalows, adequate means of transportation, and inexperience of local conditions, it was not possible to visit a number of the growers inhabiting some of the many small pockets and gullies behind the Ba, Lautoka, and Nadi districts. A certain number of these growers were visited on foot, and on horseback when a horse was procurable, but it would take nearly two months to do all these districts thoroughly, and the writer, who was rushed for time, having just arrived in the country, and possessing a limited knowledge of Hindustani, and none whatever of Fijian, was unable to make as complete a survey of the above cotton districts as he would have liked to do.

With the exception of those at Suva, Levuka, Ba, and Lautoka, there are no rest-houses or hotels, and Government Inspectors when on tour throughout the districts have to trust to the hospitality of either the Europeans or the natives, both of whom are extremely hospitable.

SEA ISLAND SELECTIONS

Lint and Seed Characters.

No.	*Length of Staple.*	*Strength of Staple.*	*Drag.*	*Density.*	*Regularity.*	*Body.*	*Colour of Tuft.*	*Colour of Fibre.*	*Colour of Seed Coat.*	*Size of Seed.*	*Weight of 100 Seeds and Lint.*	*Weight of 100 Seeds.*	*Lint Index.*	*Ginning.*	*Weight of 5 Bolls.*	*Number of Bolls per Pound.*
	Ins.										Gms	Gms		Per Cent	Gms.	
S 8	2	Very strong	Good	Good	Very good	Good	Light green	Light cream	Black	Large, bold	19·69	14·43	5·26	26·68	20·05	113
S 16	2	,,	Very good	Very good	Good	Very good	Green	White	Amber	,,	19·24	13·38	5·86	30·45	19·5	116
S 17	2	,,	Excel-lent	Excel-lent	,,	Excel-lent	Greenish-brown	Light cream	Pale black	,,	20·66	14·62	6·04	29·23	24·01	94·33
S 19	2	,,	Very good	Good	,,	Good	,,	Cream, bright	Amber	,,	18·52	13·38	5·14	27·75	18·13	124·93
S 22	1¾	,,	Good	,,	,,	,,	,,	,,	Dark amber	,,	18·65	12·61	6·04	32·39	18·68	121·25
S 25	2	,,	Very good	,,	Very good	,,	Pale green	Light cream	Black	,,	19·06	13·22	5·84	30·64	19·06	118·31
S 27	2	,,	Good	,,	Good	,,	Brown and green	Cream	Black	Large	18·88	13·38	5·5	29·13	18·49	122·49
S 30	2	,,	,,	,,	Very Good	,,	,,	,,	Dark amber	Medium	17·8	12·6	5·2	29·21	18·43	125·62
S 31	2⅛	,,	,,	Fair	Fair	Fair	Greenish-brown	Cream, bright	,,	Large, bold	18·52	14·26	4·26	22·16	18·98	119·86
S 33	2	,,	,,	,,	,,	,,	,,	,,	,,	Medium	19·52	13·64	5·88	30·12	19·27	117·54
S 36	2	,,	Fair	Good	Good	Good	Buff	Cream, stained	,,	Large	20·20	14·06	6·14	30·38	18·13	124·93
S 37	$2\frac{1}{16}$	,,	Good	,,	Fair	,,	Green	Cream, bright, fine	Black	Large, bold	20·20	14·62	5·58	27·62	19·62	115
S 38	2	,,	,,	,,	Good	,,	Green and buff	,,	Black	,,	18·32	13·70	4·62	25·21	18·85	120·5
S 39	2⅛	,,	Excel-lent	Fair	,,	Fair	,,	,,	,,	Medium	17·44	13·16	4·26	24·54	17·69	129·87

MEADE SELECTIONS.

Lint and Seed Characters.

No.	Length of Staple.	Strength of Staple.	Drag.	Density.	Regularity.	Body.	Colour of Tuft.	Colour of Fibre.	Colour of Seed Coat.	Weight of 100 Seeds and Lint.	Weight of 100 Seeds.	Lint Index.	Ginning.	Weight of 5 Bolls.	Number of Bolls per Pound.
	Ins.									Gms	Gms		Per Cent.		
M 3	1½	Very strong	Fair	Good	Very good	Good	Cream	Bluish-white	Chocolate	20 28	15 08	5·2	25·65	34·12	66·38
M 5	1½	,,	,,	,,	Good	,,	,,	Light cream	,,	22·48	17 08	5·4	32·63	32·63	69·41
M 6	1¾	,,	Good	,,	,,	,,	,,	Light cream, bright	,,	21·70	16·70	5·0	23·05	38·80	58·36
M 7	1¼	,,	Poor	Fair	Fair	Fair	,,	Cream	,,	22·1	16·77	5·33	24·17	31·98	70·82
M 8	1¾	,,	Very good	Good	Good	Good	Buff	Bright yellowish-cream	,,	23·92	18·06	5·86	24·49	37·86	59·82

KOROLEVU HYBRID AND LAUTOKA KIDNEY.

No.	Weight of 100 Seeds and Lint.	Weight of 100 Seeds.	Lint Index.	Ginning.	Weight of 5 Bolls.	Number of Bolls per Pound.
	Gms.	Gms.		Per Cent		
H 1	23·33	17·94	5·39	23 11	24·31	93·17
LK 1	23·26	16·17	7·14	30·69	26·58	85·2

A special Field Notebook has been printed for the purpose of ascertaining the best methods of planting, time of planting, and for keeping a general record which will serve as a check against the seed registers of Government agents.

Judging from data collected during the last season, it would appear that the best time to plant is between mid-November and early January, and the best land to choose is a light, well-drained, friable brown loam.

The list given on p. 113 was taken from the Field Book. The locality selected for this purpose is Bila Levu, where fairly uniform soil and general conditions prevail. It is rather interesting to note the correlation between the time of planting and the yield per acre; this remains fairly consistent throughout the whole of the Sigatoka district. The average for this district was:

Number of Growers.	*Acreage.*	*Total Yield Seed Cotton. (Lbs.)*	*Average Yield per Acre Seed Cotton. (Lbs.)*
350	615	431,888	702

Ginning and Grading.

This is under the supervision of Mr. B. L. Field. The extra gins and engines, which were expected to arrive during the last week in April last, did not reach here until the middle of July, and even then it was found that the rollers had not been included. This rather disorganized arrangements, as seed cotton was then arriving at Lautoka and took up all Mr. Field's time, so that he was unable to attend to the erection of the new ginneries.

Lautoka.—Lautoka has a three-gin stand, each gin being driven by a small Crossley engine, and is capable of turning out from 600 to 800 lbs. of lint per day of ten hours.

The cotton is pressed in woolpacks by a lever box press, such as is commonly used on sheep stations in Australia. A belt conveyer carries the seed to the outside of the shed, where it is hand-cleaned by rolling through a grid or sieve.

The cotton is graded mainly for class; grading strictly for staple has not as yet been practised. Advances up to 4d. per lb. are made on the seed cotton according to its class; any balance that may be received over and above this after sales have been effected is distributed to the growers as a deferred payment, or, as it is called locally, a bonus.

LOCATION BILA LEVU, SIGATOKA RIVER.

Name.	*Type of Soil.*	*Date of First Ploughing.*	*Date of Planting.*	*No. of Cultivations.*	*Area Planted.*	*Yield.*	*Seed Cotton Yield per Acre.*
					Acres.	Lbs.	Lbs.
Paparu ..	Chocolate loam	Early July	30/11/25	5	2	2,171	1085·5
Umar ..	,,	Early August	15/11/25	5	3	3,375	1125
Maipal-Singh	,,	Early September	15/11/25	8	4	3,312	828
Ali Raga ..	,,	Early October	30/11/25	6	1½	1,593	1062
Chandika ..	,,	Early September	26/11/25	7	2½	3,304	1321·6

(Average yield of seed Cotton per acre for November plantings = 1084·52 lbs. per acre.)

Sukhu ..	Sandy loam	Early August	1/12/25	6	2	1,579	789·5
Isar Din ..	,,	Middle October	15/12/25	5	2	1,525	762·5
Timothy ..	Chocolate loam	Middle August	12/12/25	3	1	837	837
Mathuri ..	,,	End September	15/12/25	5	2	1,083	541·5
Ram Antar..	,,	Early July	1/12/25	7	2½	1,892	756·8

(Average yield of seed cotton per acre for December plantings = 737·46 lbs. per acre.)

Munnisani ..	Gravelly loam	Early October	15/1/26	4	1	747	747
Jumman ..	Light loam	Early August	28/1/26	5	1½	1,116	744
Ghamai ..	Chocolate loam	End September	30/1/26	4	1½	481	320·6
Chandi-Prashad	,,	Early July	5/1/26	6	4	3,138	784·5
Soman ..	,,	,,	8/1/26	5	1¾	911	520·5

(Average yield of seed cotton per acre for January plantings = 623·32 lbs. per acre.)

N.B.—The implements used for the cultivations include harrows, pony ploughs, and hand hoes. Very few of the natives can afford cultivators.

Sigatoka.—The ginnery has now been completed, but ginning operations have not yet commenced. It consists of three single-acting roller gins, driven by a Crossley suction gas plant, housed in a steel gin house with a concrete floor and wire gauze sorting tables. Ginning is expected to commence next month and to continue until the middle of April.

Vanua Levu.—The site for the proposed ginnery on Vanua Levu has been changed from Naiselesele to Dreketi. It was found that the anchorage was unsatisfactory, and that Indians were not keen upon taking up cotton-growing areas at Naiselesele. The site which is now considered most suitable is that of an old Government Station which has been abandoned; good water can be obtained at a distance of one mile. It is desirable that a wharf should be erected 350 to 400 yards downstream, fair-sized boats would then be able to draw up alongside the wharf. In this vicinity there are about 1,000 acres or more of second-class cotton country, upon which I would not recommend cotton to be taken up as a primary crop, but in conjunction with rice or some other crop. Upstream from the ginnery are 2,000 acres or more of first-class cotton soils.

My advice at present is to concentrate upon the two existing ginneries on Viti Levu, and to try to keep down overhead charges as much as possible until prices improve, and there is a sufficient area under cotton in Vanua Levu to warrant a ginnery.

Should the imported New Guinea Kidney cottons prove a success, I intend isolating them in Vanua Levu on different types of soils. I certainly think that the Island has great possibilities as a cotton-producing area, but with the present glut and the low prices which are now ruling, I consider it advisable for a year or so not to attempt to greatly increase the area under cotton.

Fijians.

Up to the present little mention has been made of the Fijians as cotton cultivators; this is mainly because they have not as yet taken to growing cotton extensively, but they are gradually taking it up more and more each year, and quite a number of them in the Ba, Nadi, and Sigatoka districts are becoming keen growers. The cotton produced by many, especially those at Natutu Ba district, has been cultivated and picked extremely well.

It is my opinion that much more could be done than has been done to make the Fijian a keen cultivator. Lecturing or advising seems of little use, but I believe that a good deal of notice is taken

by them of practical demonstrations. I consider therefore that the Experiment Station might also be used as a demonstration farm, and that much good might be done by conducting some of the chiefs, or Bulis, from each district over the farm, explaining the various experiments and methods of cultivation to them.

Staff.

Two Field Demonstrators have been appointed, one a European (who will devote most of his time to the Fijians), the other an Indian. At present both of these men are undergoing practical instruction at the Experiment Station.

Four Indian labourers are kept permanently at the station for regular cultivation work, and casual Fijian labour is recruited from neighbouring villages as it is required.

Ratoon Cotton.

The ratoon question is one which up to the present has not given very much trouble, but it is likely to become more troublesome as the industry grows, unless the existing regulations are strictly adhered to and enforced.

Forty-two notices were served in the Sigatoka district during the past month, but I understand that it was found necessary to summon only two or three growers.

One of the main dangers is that many of the growers imagine that they have complied with the law when they have cut their cotton down, but fail to uproot it, with a result that it sprouts again with the first rains and becomes an excellent breeding-ground for pests. A summary of the existing regulations is given hereunder:

1. All cotton plants shall be uprooted and destroyed by fire by the owner or occupier of the land after the cotton has been picked, and no cotton plants shall be allowed to remain in the ground for the second season.
2. The Superintendent of Agriculture may from time to time by notice in the *Gazette* fix a date or dates prior to which all cotton plants shall be uprooted and destroyed by fire in the district or districts, and all such cotton plants in such districts shall be uprooted and destroyed by fire prior to such dates.
3. The Superintendent of Agriculture may from time to time by notice in the *Gazette* fix a date or dates prior to which no cotton seed shall be planted in any district or districts.

4. Every owner or occupier of any land which contains cotton plants shall register the name and situation of such land and the approximate area of cotton planted thereon by notification to the Superintendent of Agriculture through the District Commissioner of the Magisterial district in which such land is situated.

5. Any owner or occupier who fails to comply with, or who in any way evades, the provisions of these regulations, shall be guilty of an offence, and shall be liable on summary conviction to a fine not exceeding twenty-five pounds (£25), or to imprisonment for a term not exceeding six months.

Pests and Diseases.

Pink Bollworm (*Gelechia gossypiella*, Saund.).—Though most of the cotton districts have shown signs of a slight attack, it has been so slight as to be almost negligible, which makes me think that quite possibly it is being heavily parasitised by some other insect. The last pickings were, however, in some cases badly infested. It will therefore be necessary to take all precautions possible to keep it under control, and to continue the practice of thoroughly sunning the seed on iron sheets before redistributing it to the growers.

Tip Worm (*Earias fabia*).—The attacks were most noticeable early in December, and again late in February, there being a small gap between the two; this may have been due to the activity of the hornet during its nest-building time, as I believe that it controls them to a certain extent.

Cotton Stainers (*Dysdercus sidæ*).—These insects were very bad during the latter part of the season. Unfortunately there are here many indigenous shrubs and grasses on which they carry over from season to season.

Harlequin Bug (*Tectacoris lineola*).—Confined mostly to the coastal areas and carried over on a kind of local poplar known as "Thespesia populnea."

Leaf Hopper, or Cotton Flea.—These were somewhat troublesome in the wetter districts, causing a peculiar leaf curl and a certain amount of shedding.

Conclusion.

Though the cotton industry has most probably come to stay, it is not yet firmly established, and needs a little more fostering to tide it over the bad times. By this I do not mean that I consider that the growers should be pampered in any way, but merely helped to help

themselves. Practical demonstrations in agricultural methods are greatly needed, especially amongst the Fijians.

It should by gradual extension be possible to increase the output up to 5,000 bales of lint.

Owing to the great distance of Fiji from the general markets of the world, it would, in my opinion, be advisable to specialize in limited areas of either Sea Island or some other high-quality cotton.

The Government of Fiji is undoubtedly anxious to do all in its power to foster the cotton industry, providing that by so doing it is not embarrassing any of its other industries.

Received February, 1927.

COTTON-GROWING IN NORTHERN RHODESIA

REPORT FOR THE SEASON 1925-1926

BY

E. F. SALTER,

Cotton Specialist in Northern Rhodesia.

My first year's experience in Northern Rhodesia was not of the most encouraging nature, and it is clear that much work will be required before the cultivation of cotton can be placed upon a sound and profitable footing in this country. The chief difficulty at the present time is the climate, which during the past season has been distinctly upon the "abnormal" side, and which will apparently have to be taken into very serious account in breeding and other work. The rainfall in 1926 at the various recording stations in the different districts was as follows:

Broken Hill	50·99 inches.
Chilanga	37·32 ,,
Chisamba	51·36 ,,
,, West	42·84 ,,
Choma	38·35 ,,
Kafue	36·85 ,,
Kalomo	36·19 ,,
Livingstone	27·43 ,,
Lusaka	44·17 ,,
,, West	47·46 ,,
Mazabuka	32·39 ,,
Monze	25·20 ,,
Pemba	29·74 ,,

I would like to point out that the above readings are only taken from one gauge in each district, and it is, therefore, not the average rainfall for each particular district, but simply the amount that fell at a certain point. I mention this because rain is so very local here, and it often happens that one day a farmer gets a lot of rain, but his neighbour does not receive any. The rains are generally expected about the middle of November, but this year many farmers did not receive any until the first week in January.

Insect Pests.—The chief trouble has been the climate, but insects also have done some damage. We have here the American and Spiny Bollworms, Stainer and Jassid, and all of them caused a considerable amount of damage. I am unable to say definitely which caused the

most harm, but I am of opinion that the Red Stainer was responsible for a lot of our trouble.

Acreage.—It was anticipated that the area planted to cotton in the country would have been nearly 20,000 acres, but as in many places the rains did not arrive till the beginning of January, the area was reduced, it being then too late to sow cotton. The total area planted (annual and ratooned) was 14,387 acres. Details as follows:

RATOONED.				ANNUAL.					
Improved Bancroft.	*Arizona.*	*Watts' Long Staple.*	*Unknown.*	*Improved Bancroft.*	*Arizona.*	*Watts' Long Staple.*	*Uganda.*	*Zululand Hybrid.*	*Unknown.*
Acres 2,077	Acres 1,153	Acres 3,045	Acres. 125	Acres. 3,833	Acres 1,380	Acres 2,617	Acres 21	Acres. 6	Acres. 130

Labour.—At the present moment this is adequate, but many farmers have expressed the opinion that in the event of a good cotton crop they would have great difficulty in finding sufficient labour to pick it. My own view is that in certain districts this might be so, but I do not think that there would be a general shortage.

Yield.—The approximate total yield of cotton for the country was 200,000 lbs. of lint, which works out at 13·9 lbs. to the acre. I am unable to give the exact figures, as a few bales of seed cotton were sent to the ginnery after it had been shut down.

The early sown fields of cotton looked very promising till about the end of March, after which date it was very obvious that, owing to excessive rains precipitated over a short period, and to insect pests and fungous diseases, the crop would be a failure. Most of the cotton that was harvested was of a very poor quality.

Experiments.—A few varieties of cotton were sown at Chilanga, but owing to climatic conditions and pests the plots were almost a total failure; it was apparent, however, that Watts' Long Staple cotton was much more susceptible to jassid than the other varieties. All the varieties were sown on December 1, and picked on July 6. The table on p. 120 gives the results of the experiments.

Most of the varieties were obtained from Mr. Parnell. They were all sown on December 1, and as we had no further rain till January 3, we had to resort to hand watering.

Prospects.—Owing to the complete failure of the crop of the last two seasons, the acreage to be planted this season will naturally be reduced; apart from this, I have advised the farmers to sow only

small areas up to about 50 acres. This was done with the approval of Mr. Milligan.

Although the farmers have suffered considerable financial loss, many of them have not lost hope and are still convinced that with a normal season cotton will do well, and they also realise that a "mealie" crop following cotton gives them a heavier yield per acre.

Variety.	*No. of Plants.*	*Bolls.*	*Proportion of Bolls affected with Rot.*	*Yield.*
			Per Cent.	
Uganda	437	822	70	2½ lbs.
Arizona	433	740	80	23 ozs.
Watts' Long Staple	440	475	90	21 ,,
Improved Bancroft, 186 ..	310	330	70	14 ,,
,, ,, 013	377	362	90	16 ,,
,, ,, 021	383	267	90	16 ,,
,, ,, 0	292	202	70	8 ,,
Zululand Hybrid	510	202	80	13 ,,
Cleveland	377	231	90	7 ,,
Webber 49	437	264	90	9 ,,
Z1	83	29	—	2 ,,
Cambodia	49	9	—	3 ,,

Personally, I do not feel justified in giving any definite opinion as to future prospects after only one season in the country, and that an abnormal one. On the other hand, I have noticed certain things which are encouraging. When going round the country I noticed that in many of the cotton fields there were quite a number of plants which seemed practically resistant to both weather and pests, and farmers have been advised to collect the seed from these plants. In these circumstances it would appear that if we can once get the right seed cotton will be successful in the country.

Another source of encouragement to me is the fact that one farmer got 80 lbs. of lint to the acre over 100 acres of land—the cotton being Arizona and Bancroft—and I feel, therefore, that if 80 lbs. of lint can be obtained from one farm in an abnormal season like this, there is no reason to be pessimistic about the future.

An Experimental Station is being established at Mazabuka, but we shall not be able to start any cotton experiments there this year. I have obtained several varieties of different seeds which are being sown at Chilanga, and until it is possible to give these experiments a fair trial, I think it will be agreed that the policy to be recommended to the farmers should be one of caution.

Received January, 1927.

COTTON-GROWING IN SOUTHERN RHODESIA

REPORT FOR THE SEASON 1925–1926

BY

G. S. CAMERON,

The Corporation's Cotton Specialist.

DESPITE the failure of the previous year's cotton crop in Southern Rhodesia, the attitude of the farmers at the beginning of the 1925-26 season was one of determination to give the crop another trial on the same scale. Their attitude can be accounted for by the fact that, in Southern Rhodesia, the 1924-25 season had been one of unprecedented rainfall. They reckoned, therefore, that the 1925-26 season would, in all likelihood, turn out to be a dry year when, in their opinion, cotton ought to do very well, judging by results obtained in 1923-24, which was their driest year.

The late arrival of sufficient rain prevented many farmers from getting their land into good tilth, with the result that when eventually the cotton was planted, in all probability it was too late. This fact has to be kept in mind when considering the behaviour of the crop towards the end of the season, a point which will be dealt with later.

Another effect of the late arrival of the rains was to give a certain amount of stimulus to ratooning, which practice would not otherwise have been quite so general, as many farmers merely held on to their ratooned cotton as an insurance against the late arrival of planting rains. In doing so it is evident that they have not yet realized the danger of carrying over a cotton crop from one season to another. This is unfortunate, as there can be no doubt that such a practice also helps to carry over insect pests from the previous crop. It was very noticeable how much greater was the number of stainers on ratooned compared with annual crops, except where the two crops were grown side by side. Where this was done, the stainers bred up and multiplied on the ratooned cotton, and transferred their attention to the annual crop after the ratoon crop had ceased to produce bolls. It is not surprising, therefore, that a number of farmers were misled into believing that their annual cotton suffered just as much from insect pests as did their ratooned crop. What many failed to perceive was that, but for their ratoon cotton being alongside, their

annual crop would not have suffered so badly. Further reference to ratooning will be made later.

To continue with the opening of the season. Once the rains commenced they did so in real earnest, and more than made up for lost time in quantity, continuing, generally, till about the middle of February, when there occurred a dry period till about March 10. During this time the crop looked very promising indeed. Plants were heavily laden with young bolls, and profuse flowering gave indications of a heavy second and third picking. It would be as well to state here, however, that any remarks on rainfall or weather conditions have to be considered in their general application to the country, as in Southern Rhodesia rainfall is often very localized. It is very common to have heavy rain on one farm and none at all on the one immediately adjoining.

Early March witnessed a break in the dry weather, and it may have been about this time that the cotton received its severest check throughout the season.

The rain which fell at this period did much damage to the crop, and the water table must have risen considerably about the same time. This resulted in a general weakening of the plants, which rendered them more susceptible to insect attack, particularly jassid and red stainers (*Dysdercus sp.*). Flower and boll shedding became very severe, and for a time the prospect was far from bright. After a time, however, the crop seemed to rally, and it appeared to the writer that the plants were carrying many more bolls than at a corresponding period the previous year, and this apparently was the opinion of farmers throughout the country generally. The bolls were on the plants right enough, but whether they would open out properly was another question. There appeared to be sufficient time for them to do so before the cold weather set in, but it is necessary at this point to bear in mind that the crop had been planted late. Even so, however, it looked as if a fair amount of cotton should be ready for picking about the middle of May.

Official Forecast made in April.

It is questionable if sufficient experience of the cotton crop in Southern Rhodesia has been gained to justify the issue of a crop forecast. As a beginning has to be made sometime, however, an attempt was made in April, by which time it was thought the crop would be sufficiently far advanced to enable a yield forecast to be made. On being requested to furnish such a forecast, the writer had no hesitation in making the attempt.

At that time it certainly appeared as if the crop had encountered all the vicissitudes of the season, and that nothing further could possibly happen to it before the picking season commenced. Taking the country district by district, and multiplying the area in each by the average yield obtained in 1923-24, a figure of 18,000 bales of 500 lbs. each was obtained. From what one could gather in the course of conversation with farmers who had grown the crop in 1923-24, the crop did not promise to yield as well as it did then, but it was reckoned to be possibly about two-thirds as good. This would give a figure of 12,000 bales. Even this appeared to the writer to be too high, and after giving the matter much consideration, a figure of 10,000 bales was eventually decided upon. This estimate was by no means a "shot in the dark," and was only decided after much figuring out of the results obtained the two previous years. Even so, however, the writer qualified it as a "well-considered guess," and it is questionable if anything better can be evolved for some time to come. The writer feels, however, that a much better attempt could be made at forecasting the cotton crop about the end of May—that is, in some years; other years it might be possible to issue a forecast much earlier. It all depends on the season. In a year of early rains and, therefore, early planting, combined with a dry autumn, it might be possible to give an official forecast about the end of April.

Subsequent events reveal the fact that the estimate of 10,000 bales was much too big, but it is to be understood that *at the time the forecast was made*, it did not appear to be so, and it was made with every confidence that the crop would reach the figure indicated. The actual number of bales has only amounted to 5,442 of 500 lbs. each. This, however, does not represent the full amount of cotton grown, as much of it was never harvested on account of its poor quality, which, combined with the fall in cotton prices, did not justify the expense of picking it.

What happened was as follows. The plants appeared healthy, and carried quite a fair number of bolls, which looked as if they should begin to open in from three to five weeks' time. The nights began to cool off rapidly, but the days continued bright, with plenty of hot sun. Despite this the bolls "hung fire" for six or seven weeks before they gave any indication of opening. When they did so, eventually, their manner of opening was far from satisfactory. They merely cracked without opening fully, giving the impression of bursting prematurely. At this stage it was impossible to state just what might happen. In some cases, all too few, the bolls eventually opened out properly, but in the majority of crops the bolls remained

half opened until late in the season. When the bolls came to be picked the operation was carried out with difficulty. Instead of the seed cotton coming away freely, it meant that each lock had to be picked separately, thus adding very considerably to the cost of picking.

The failure of the crop to open out properly constitutes the outstanding feature of the season, and demands serious consideration. Its behaviour cannot be attributed to any one particular reason, as no doubt there are several.

First of all, as has been stated previously, the crop was planted late—that is, late for a "wet" year. In the 1923-24 season cotton was planted as late as January, and appeared to do as well as cotton planted in December. In a "wet" year, however, late December planting may just be too late.

In addition to the crop having been planted late in what ultimately turned out to be a very wet year, the distribution of the rains was not normal. It was not so much the total amount which fell in March that did the damage, as the very heavy showers which were experienced, especially in the Concession, Glendale, and Mazoe areas.

Not only was it a wet year, but, coming as it did on top of the wettest year on record, the cotton crop suffered from the cumulative effect of the two seasons.

The following table of rainfall in eight cotton districts for the past two years clearly indicates the two very wet seasons which Southern Rhodesia has just experienced. With the exception of the 1925-26 season at Gatooma, all are approximately ten to fifteen inches above normal. Although Gatooma shows a subnormal rainfall for the 1925-26 season, the planting rains were so late and badly distributed as to make the ripening and harvesting period correspondingly late.

Area.	1924–25.	1925–26.	*Normal Annual Rainfall.*
Banket	46·30	42·46	32·80
Gatooma	52·34	25·05	31·48
Sipolilo	42·62	43·27	31·64
Sinoia	44·92	43·59	31·51
Glendale	44·70	45·34	35·08
Mazoe	51·66	54·11	33·00
Odzi	55·17	51·64	37·64
Umtali	58·52	43·08	34·72
Average of the above eight districts ..	49·52	43·57	33·48

Bad as the last two seasons were, however, it should have been possible to produce more and better cotton than has been produced had the country been in possession of a better seed supply, and possibly a better variety of cotton. In some districts the quality of cotton seed was so poor that it is surprising that so much of it germinated. The question of seed supply is the one outstanding problem facing the cotton-growing industry at the present time. The work of selection and the investigation of new varieties is being undertaken at the Government Cotton Breeding Station, Gatooma, where the results of the first year's work show that earlier maturing and heavier yielding varieties exist.

It will be some time, however, before sufficiently definite results can be expected from Gatooma. Meanwhile it is necessary to carry on with the stock of seed already in the country. Unfortunately this is such that there is not much prospect of the cotton industry flourishing as long as we are dependent on it, if the next few seasons turn out to be as wet as the last two.

Despite the adverse season, indifferent seed, and other deterrent factors, however, it is significant that in each recognized cotton district throughout the country a few good crops were produced. Why this should be the case is not quite clear. If it were, one could reasonably claim to have solved the several difficulties which confront the industry. These comparatively good crops were found growing under varying conditions of soil and altitude. It may have been that the growers were more fortunate than their neighbours in possessing better strains of seed, but this does not altogether account for the exceptional cases. It is pleasing, however, to be able to record that good crops were grown, even if one has to admit that they were widely scattered.

Seed Supply.

Considering the poor quality of cotton seed which has been sold for planting purposes in the majority of cases, a scheme for certifying seed from specially selected crops was inaugurated, and put into practice towards the end of the season. The scheme, briefly, is as follows:

Farmers desiring to have their cotton crops examined for approval as sources of sound seed for planting purposes communicate with the Secretary, Department of Agriculture, giving an undertaking that they are prepared to abide by the following conditions:

1. All clean, white seed cotton, free from stain, dirt, or trash of any kind, will be picked separately, and packed in wool packs suitably

marked to indicate that the contents are to be specially ginned for seed.

2. Such seed cotton to be ginned in the presence of the farmer himself, who will make arrangements to see his cotton ginned, and the seed sewn up in clean bags marked with the farmer's name or mark.

3. In the event of the seed being finally approved, the owner will give an undertaking to sell it for not more than 3d. per lb.

In addition to the examination in the field, the seed from selected crops will be finally examined at the ginnery by officers appointed by the Department of Agriculture, who will affix a seal on all bags which have been passed.

When the above arrangements were made, it was not known how many farmers would apply to have their seed examined under the scheme, and whether the available staff would be sufficient to carry out the work. One mistake was made, and that was that no definite date was laid down by which time no further applications would be received. This meant that inspectors under the scheme had to retrace their journeys on several occasions to inspect the crops of late applicants. Otherwise the scheme was proved feasible, and can be put into operation in future if and when there is a demand for it.

About sixty farmers applied to have their crops examined out of a probable total of one thousand cotton growers. Of these only twenty-five were considered to have crops sufficiently good to be recommended for seed purposes. The work of inspecting the crops and finally inspecting the seed at the ginneries was carried out by the writer, together with Mr. Peat, Plant Breeder at Gatooma, and Mr. D. D. Brown, Government Cotton and Tobacco Adviser, Bulawayo. To both these gentlemen the writer is indebted for the able and willing assistance rendered by them.

At the date of writing it is not known how much of the approved seed was taken up by the farmers. It is feared that the quantity is not as great as it might have been, considering the trouble and expense involved. The reason for this is no doubt the fact that so many farmers were disappointed with their attempts at cotton-growing during the last two seasons, to which must be added the discouraging effect of the drop in prices. It is known that many are planting their own seed again in order to save the cost of purchasing it. Whether it be real economy to plant seed much of which will not germinate, and when it does is likely to give weak, unhealthy plants, will have to be left for the farmers to find out for themselves. They cannot be forced to plant any particular kind of seed, and if they desire to do otherwise no one can stop them in the meantime.

RATOONING.

Reference has already been made to the practice of ratooning of cotton in Southern Rhodesia. For the benefit of those not acquainted with conditions in the Territory, it may be as well to emphasize the fact that the cotton industry at present is in the hands of white farmers, European and Colonial born. This fact has to be borne in mind wherever there is any question of legislation in cotton matters. To legislate in a country where the farmers are mostly natives is one thing, but it is entirely different when dealing with white farmers. For this reason it has been considered advisable to withhold the making of any laws prohibiting the ratooning of cotton. Many farmers in Southern Rhodesia are at present convinced that ratooning pays them better than annual cotton. There is a certain amount to be said for them, as they have not yet reached the stage of being able to analyze the situation properly. For instance, the writer has been told by farmers, time and again, that they got a better price for their ratooned cotton than they did for their annual. The reason for this ought to be fairly obvious, as their ratooned cotton came on the market about May and June, whereas their annual cotton is rarely sold before July or August when sold locally, and much later than this when sent to Liverpool. Under these circumstances it is but natural that the ratooned cotton should command a higher price in a year such as the present, when the market has been steadily declining all the time.

The case has already been mentioned where annual and ratooned cotton have been grown side by side, to the apparent advantage of the latter, in ignorance of the fact that the annual has suffered from insects, especially stainers, which have been encouraged by the ratooned cotton growing next to it.

Again, the past two seasons, on account of their having been cold and wet, have given the ratooned cotton an advantage which it is not likely to enjoy in normal seasons.

It is only fair to state, however, that there are also a very large number of farmers who have tried ratooning and are convinced that it is not a sound practice. Opinion is still not sufficiently unanimous to encourage the belief that legislation should be undertaken to prohibit ratooning.

The Ensuing Season, 1926-27.

Rains were again late, but when they did arrive they were favourable in that they were continuous without being too heavy. Despite the poor quality of seed planted, germination appears to be fairly regular.

Nothing can be said as yet as to the area planted, but there are indications that it will be more than originally anticipated. In the main cotton areas farmers appear to be putting in about fifty acres, but there are quite a number exceeding this amount. On questioning them as to their reasons for doing so in face of the evidence of the last two seasons, the reply is generally that they found cotton such a good rotation crop for their mealies that they are prepared to go on with it even though it does not give them the profit they originally anticipated. They also stress the point that, the last two seasons being so abnormal, it is unfair to judge the behaviour of the crop during that time. The farmers referred to, in nearly every case, are men of long standing in the country, who have made a success of their other farming operations, and it cannot be said of them that they are growing cotton "on spec." Rather may it be said that they have a shrewd idea that cotton is suited to Southern Rhodesia in normal years, and the opportunity of finding a suitable crop to alternate with mealies is too good to miss without giving it a thorough trial. It is true that the "boom" has gone out of cotton, and is now confined to tobacco. This is by no means a matter for regret, as there are few crops better suited to breaking in new land than tobacco, after which cotton does exceptionally well. On this account the boom in tobacco is rather welcomed than otherwise, as every acre cleared for tobacco becomes a potential acre of cotton in the future.

The Government of Southern Rhodesia.

It is but fitting that mention should be made of the cordial relations which continue to exist with the Government of the country. Their keen and sympathetic interest for the good of the cotton-growing industry has manifested itself in many ways, and the writer, on behalf of the Empire Cotton Growing Corporation staff in Southern Rhodesia, takes this opportunity of recording their grateful appreciation.

Working in as close co-operation with the Government as we have been doing for the past two years, one cannot but be impressed by their earnestness of purpose in everything which promises to be for the good of the country.

The Department of Agriculture.

This report would not be complete without mentioning the valuable help received from the staff, both technical and clerical, of the Department of Agriculture, with whom it has been a pleasure to associate in our work.

Conclusion.

Again the writer has to thank the public, especially the farming public, for many kindnesses received while in their midst. Our work has never been easy, and frequently disappointing, but it has always been a pleasure to work with the farmers of Southern Rhodesia. They, too, have had their difficulties and disappointments, but they are carrying on in spite of them all; and seeing their determination is an incentive to do all that is possible towards establishing the cotton industry on a sound footing in this small but very delightful part of the Empire.

Received February, 1927.

DEFEATING THE OPPOSITION

BY

W. GILHESPY.

JOHN MORTON, I.C.S., District Magistrate and Deputy Commissioner of Rambatganj District in the Punjab, desired the *zemindars* of his district to grow cotton—was determined that they should grow cotton. They were equally determined that they would not. That was because they did not know John Morton.

"You will waste your time if you try to grow rice without a better head of water," he told them. "You can't grow sugar cane for the same reason. The prices for *jowhari* and *bajri* (maize and pulse) are not what they were, and you can't grow tobacco continually. If you grow cotton, and make up your minds to grow it properly, it will pay you well."

"Most assuredly we will grow cotton if the protector of the poor orders it," they declared, without the slightest intention of doing so. Then they began to explain why they could not grow cotton, and the Deputy Commissioner listened in grim silence. "Explain" is scarcely the right word, perhaps. The average Indian cultivator prefers to spend the long, lazy day in talking round a question to saying just exactly what he means.

Those cultivators did not wish to grow cotton because they preferred to grow the crops which their forefathers had grown, and with as little trouble as possible. Cotton had never been grown in that district, and why should they begin? Millet is very much easier to grow, and every *harri* (ploughman) understands its cultivation. Cotton? Why, the man who grows cotton must give his *personal* attention to it!

Their forbears had grown millet—*jowhari* and *bajri*—without any need to go near the fields till the crop was harvested. It was so much easier to work on the *battai* system. All one needs do is to let out the land to some poorer cultivator who has not enough land of his own, or who is so fast in the clutches of the moneylender that he cannot afford to seed it. The small man does all the work, takes the bigger share of the risk, the smaller share of the profits, and one has no trouble at all.

Besides, millet is so easily grown. The *zemindar* (landowner)

just waits until the snows of the distant Himalayas melt and flood the mighty Indus, the water is led along canals constructed by a benign Government, and the land is irrigated. A few days later the seed is broadcast and lightly covered with wooden ploughs and—there you are. If there should come a favourable season, followed by a good harvest—well—so much the better. If not, then nothing is gained by repining. It is all kismet.

But good crops of cotton could not be grown so easily. It needs more and better cultivation. It may be attacked by boll worm, both the *gulabi* and the *tikri-tikri* (the pink and the spotted). It must be picked carefully, and, unless one keeps a close watch on the pickers, they are sure to pick carelessly, with the result that too much rubbish is thrown into the baskets and too much good cotton left on the plants.

Still, they wanted the land. It was quite easy to say they would grow cotton, and just as easy to find many good reasons afterwards for not growing it. So they told the sahib that he was the fount of all wisdom and justice, besides being their father and mother, and they would certainly grow whatever he advised.

"You will," said Morton, with grim emphasis, well aware of their intentions. These men were strangers to him, but he had lived and worked among cultivators for twenty years.

He had been sent to complete the "colonization" of the newly formed district soon after the last made canal was ready to hide an arid desert under crops of waving corn and cotton that flaunted its hibiscus-like bloom and its snow-white bolls in their seasons. Much of the land had been allocated before he was transferred to the district, some of it to men of whom he did not approve. There were thousands of applicants for the remainder, and it was Morton's task to allocate that.

He did it well. He loved the land. He was descended from a long line of landowners, who had loved and worked the soil by which they lived. Other administrators and executors, quite as eager to do their best for agriculture, India's chief industry, knew very little about it. Knowledge of the land and its needs, together with contempt for the lazy, slipshod, grasping methods of men who were granted land all too easily, was part of Morton's being.

So he gave his best attention to the claims of each applicant for a slice of land. The claims came in shoals. They came by post, couched in the quaintest phraseology. They were urged in person by suave aspirants who could produce innumerable reasons as to why they should be specially favoured. Some had fathers and grand-

fathers who had served the State. One was a magistrate who had been dismissed for taking bribes, some had failed to obtain appointments under Government, some had failed at everything they had tried. There were doctors, lawyers, magistrates, editors, and money-lenders, who, as Morton knew, would let out the land on *battai*, and fleece the wretched cultivators.

There was rejoicing and there was bitter indignation when the Deputy Commissioner gave his decisions. Those who were not cultivators or were not likely to learn the art, all those who would not bind themselves to live near their holdings, were sent empty away. Those whom he believed fit for the privilege were given some land, and promised more if they worked their holdings to his satisfaction. The disappointed ones wrote to the native Press about the *zullum* (injustice) of the new Deputy Commissioner.

The cultivator pays a moderate tax on his acreage under crops each year. Partial failure of any one crop entitles him to forward a claim for remission of taxation, and it is part of the Deputy Commissioner's duty to consider such claims. The actual appraisement of claims and crops is left to his subordinates, who send in their reports, but their superior grants or refuses abatement or remission at discretion.

Much to the *zemindars'* dismay and to the confusion of those subordinates who had been bribed, Morton inspected some of the land on which claims had been made.

"Ah, poor price for millet and a 'ten anna' crop," he commiserated. "Pity you didn't grow cotton. I told you cotton would pay better than either *jowhari* or *bajri*."

"*Huzuur*, we could not cultivate and manure sufficiently well for cotton."

"Then you should not have applied for land which you cannot cultivate properly. No remission."

"Only half, *huzuur*—just this once. You are my father and my mother, and I am a very poor man with a large family."

"All the more reason to grow cotton; quite small children can help with that, and you would have saved on labour. No remission."

The native Press howled. The native Press, with a few honourable exceptions, has built up its circulation by howling in season and out of season. Editors who would scarcely have known cotton from tobacco in the early stages of growth explained, with wealth of detail, just why cotton could not be regarded as a profitable crop in the Rambatganj District. Some had sons, uncles, cousins, or nephews who had made unsuccessful applications for land, so the editorial

pens were dipped in gall. Their readers were told of terrible cases of hardship and oppression, of ruined cultivators who had been unable to pay their miserable *harris* because an administrator with a heart of granite was resolute that a grasping Government should have its pound of flesh.

Those who sat in the seats of the mighty were alarmed, demanded an explanation, and Morton gave it. But he knew that he must do more than explain in future; he must prove that cotton could be grown at a profit—a substantial profit—both to the farmer and to the revenue. He knew that the men who had shirked the attempt would only grow it under compulsion, and that they would make sure that the crop would fail. The whole miserable business would end in his being transferred, unless he could give actual demonstration that the profit from well-grown cotton would exceed that derived from any other crop.

He was prepared, his plans had been cut and dried for a year. He had lived too long among Punjabi cultivators, and knew the wiles of the malcontents who dupe the simple-minded farmers too well to be caught napping. In so far as he could, he had allocated the land among residents of the district, but had reserved a thousand *zareebs* (five hundred acres) for the purpose he had in view. Half of this he now offered to two earnest cultivators of a neighbouring district.

"Abdul Latif, you two have both grown cotton for years," he reminded them. "Well, I will give you each two hundred and fifty *zareebs* of virgin soil if you put half of it under cotton. Your neighbours will not give you a hearty welcome, they will try to discourage you—may even try to prevent your growing cotton. Keep an exact account of all you spend, put your backs into the business, and you shall have as much more land next year. Well ?"

They promised—and meant to keep their promises. They believed in cotton and they believed in Morton.

They were regarded as interlopers, they had been granted land which residents had hoped to acquire. They were protégés—allies—of the white oppressor who had dared to interfere with time-honoured methods of working—or rather of leaving work undone. When they began to clear the land for cotton they were regarded as enemies.

They must be prevented at all costs. When they were ready to plough they could not buy bullocks—no one would sell. Labourers had been quietly warned not to work for them. They sent to their homes for cattle and men—hefty men who loved work and who could fight if necessary. They stripped to the waist and worked as

though their lives depended on it. They had pluck, and they needed it. Their fodder was stolen or burnt, cattle were turned into their forage crops by night, their own beasts were driven away while they slept, the small cross-channels they had built for irrigation were broken down during the night. Certainly they needed pluck.

But even their courage would have failed had not Morton been behind them. Unknown to them, he had given the police inspector instructions to keep a watch on their enemies, and the inspector had sent Khair Din, a reliable man of the secret police. Khair Din was only one of half a dozen who hawked fruit and cakes among the men who toiled in the fields, or sat at the door of their temporary huts when evening fell. He gathered very little wealth by his trading, but he did gather a lot of information. He stole quietly to Abdul Latif's hut as the tired men finished their evening meal.

"Men will come after the second watch of the night," he warned. "Have water ready—much water—for they will burn the sheds. Also they will drive the bullocks many miles, so that they will never be seen again."

Soon after midnight the depredators arrived. Agricultural hand implements are very effective weapons when wielded by sturdy Punjabi cultivators who are fighting for the right to live and getting quite a lot of pleasure out of the fight. Of those who came to terrorize, the most ran home as fast as they could; those who had to be carried went rather slowly.

There were summonses and cross-summonses. Morton had the cases transferred to his own court. He dismissed the cases against the newcomers and sent the men who had been carried home from the fray to prison. Then their employers, some of them men of wealth and position, listened to Morton's remarks and hung their heads. They had escaped imprisonment solely for lack of proof that they had instigated the cowardly attempt, but the lash of a whip could not have hurt so much as did the magistrate's denunciation of their cowardly conduct. Ashamed and humiliated in the presence of the men over whom they had wielded patriarchal influence, they crawled away, stripped of the last vestige of authority.

"There is one man whose name does not appear, but who is the instigator of all the trouble," the police inspector reported when the court closed. "He is Devi Dass, a *bunnia* and a bad lot. Very smart and very smooth-tongued, but bitterly opposed to authority. I don't know why."

"Neither does anyone else. I'm afraid we'll have trouble with that fellow; he seems to have a lot of influence."

"I'm not quite so sure about that, sir—oh, yes, he *has*—but only with the brainless chaps. Many of the others ignore him and others distrust him; they'd all turn against him if we could once get hold of him. I am leaving that detective here, sir."

Those who had been humbled in the dust would listen to Devi Dass no longer, but there were others on whom the arch-conspirator could play.

It was easy to convince them that they were being oppressed, because they wished to be convinced. Why should they grow cotton if they did not really wish to do so? What right had the Deputy Commissioner to dictate to them? They had always paid their taxes—or such portion as they were compelled to pay. Now, as Devi Dass was careful to point out, Morton Sahib would have a hold over them if he could demonstrate that they could grow cotton at a big profit, pay their revenues easily, provide employment, and increase the wealth of the country. Abdul Latif and his brother were Morton's willing helpers; they *must*, as Devi Dass explained, get rid of them.

He evolved a scheme that was admirable in its simplicity. The land on which the strangers were growing cotton was near the main canal and some seven feet below it. If the earthen rampart were breached at night, water would flood every part of the cotton area, carrying with it enough of the bank to spread tons of earth over the irrigation beds and ruin the crop.

It was a good plan, but no one was prepared to carry it out, because no one was prepared to risk imprisonment. Again Devi Dass was constrained to take the lead. He hired two ruffians who would do the work as directed, take their pay, and be far away before the damage was discovered.

Khair Din rejoiced when he saw them. He knew them, though they did not know him, and he knew that he would soon be engaged on work very much to his liking. As a hawker he had opportunities of making acquaintance with newcomers, and when he found them taciturn, he smiled pleasantly and went his way.

An hour later the inspector received an extraordinary telegram, which referred to two stray bullocks with certain marks and brands, and took it to the District Magistrate.

"This is from my man at Rambatganj, sir," he reported. "It's his way of explaining that two ex-convicts have turned up there, that there's going to be trouble of some sort, and that help will be needed. I've sent another good man to get in touch with him, and I'll ride over after nightfall."

"Good. Yes, they won't get busy during daylight. I'll go too; we can leave here about six."

So it was that, when Harchandrai and Kundoomull, gentlemen of adventure who knew quite a lot about Punjabi jails, set out at midnight on their errand of destruction, Khair Din shadowed them. Abdul Latif and his men were ready to give all the help needed, Morton and the police inspector were within hail.

"Perhaps we'd better lie low till we're called," the former said. "Abdul Latif may get from them information that will incriminate their paymaster better than we can."

Abdul Latif did. Punjabi cultivators are not always gentle in their methods; the ex-convicts had no hope of mercy at their hands, and no compunction in incriminating the man who had employed them.

"It was Devi Dass," Harchandrai admitted, and breathed more freely when his interrogator returned his gun to its place. The muzzle of an unloaded gun pressed against his bare chest had been most uncomfortable, but quite effective.

"I don't think we'll have much trouble in getting corroborative evidence against Devi Dass," the inspector opined, after the criminals' statements had been recorded. "I'll stay here, sir. Those *zemindars* to whom you gave a wigging will be jolly glad to crawl back into favour by putting us in the way of finding witnesses, especially with Devi Dass out of the way."

Rambatganj District is on the high road to prosperity, and supports twice as many cultivators as it did when Morton first took charge. Its chief export is cotton, and under the co-operative system conditions are steadily improving.

APPLIED ENTOMOLOGY IN RELATION TO THE AGRICULTURAL RESOURCES OF A COUNTRY

BY

H. H. KING,

Government Entomologist, Sudan.

TWENTY-FIVE years ago applied entomology, as an essential service in an agricultural country, was only beginning to receive recognition.* There was a general impression that while any Government responsible for the administration of a colony or protectorate should employ an entomologist, that official was almost a luxury, and the one man should be able to deal with all pests occurring throughout the country, whatever its size. Experience has shown that, far from being a luxury, the applied entomologist is a necessity, and that unless due provision is made for the control of pests, the revenue of the country will suffer. In 1906 the Sudan Government appointed an entomologist, and five years later, when reviewing the probable future requirements of the country in scientific staff, the then director of the Government laboratories expressed the opinion that a second entomologist would be required; at the time of writing (1927) the staff of the Entomological Section includes eight entomologists. This increase in the number of entomologists has coincided with the expansion of cotton-growing, and may be taken as proof that those responsible for the development of the country, particularly the agricultural development, are convinced of the need for pest control. If the Government were not satisfied that adequate return was received for the expenditure on the entomological service, this staff would not be maintained.

When a Government undertakes the administration of an area in Tropical Africa, it also undertakes the development of the natural resources of the area with a view to raising the general standard of living of the inhabitants. In the absence of great mineral wealth the resources will be agricultural. The Government, therefore, examines these agricultural resources and formulates a policy; certain

* To the best of our knowledge, the first official appointment of an Entomologist in the warmer parts of the Empire was that of Mr. E. E. Green (late President of the Entomological Society) in Ceylon in 1897.—ED.

districts may not be capable of much development, while others clearly possess great possibilities. Decision is reached as to the agricultural staff required, and, at the same time, the question of the entomological staff should be considered. While it may be fairly easy to determine what staff of agriculturists is needed—their duties are well understood and clearly defined—it is not necessarily easy for those in authority to decide on the strength, composition, and organization of the entomological service. It is proposed to examine the various factors affecting this question with a view to indicating how a conclusion may be reached.

What are the duties of an entomologist? Primarily, he is required to devise means for protecting the inhabitants of the country from losses due to pests. In practice, it will be found that his duties are wider than this would appear to indicate. It is not enough that he should carry out quiet research and publish his results; agriculturists, both those employed by Government and those engaged in private enterprise, will ask that he should inspect their crops at intervals to report on their condition as regards pests, and generally give helpful advice on the subject of pest control. Again, his assistance will often be sought in the organization and carrying out of control measures, especially when such measures need to be modified to suit local conditions. He should aim at establishing such relations not only with European agriculturists, but also with the native cultivators, so that they will come to recognize him as one to whom they may turn whenever their crops are threatened. It is sometimes suggested that the work of the entomologist engaged in research in a laboratory is entirely distinct from that of the entomologist who spends a large proportion of his time on tour, but the writer holds strongly the contrary view. Both are working with the same object—the protection of the crops from pests; and while one is studying in detail the habits of the pests under laboratory and local field conditions, the other is studying their habits under field conditions over a wide area, and the factors which require consideration when actual control measures are being devised. Their work dovetails just as, to use a medical simile, the work of the clinician and of the epidemiologist dovetails, and it is only by their close co-operation that the best results can be obtained.

It may be noted here that, while innumerable and interesting problems offer themselves to the entomologists for study and research, the Government of a country, with a limited revenue and in process of development, cannot contemplate spending money on other than those sometimes spoken of as *ad hoc* problems. As to which are and

which are not problems of this class may sometimes be a matter of opinion, but those responsible for deciding on the work undertaken should bear in mind that the primary object of an entomological service is the protection of the inhabitants of the country from serious loss, direct or indirect, due to pests.

How many laboratories will be needed? Given that the climatic and agricultural conditions are relatively uniform throughout the country, a single laboratory is all that is required, but if this is not the case, the work must be decentralized, as it is essential that the bionomics of a pest and methods of control be studied under the conditions in which it occurs as a pest and in which the control measures will be carried out.

To consider the case of a country such as the Sudan, which includes within its borders approximately one million square miles with widely differing conditions of temperature, rainfall, soil, and other factors affecting agriculture. Such a country may, for the purpose under consideration, be divided into definite zones or districts, within each of which the climatic and agricultural conditions are relatively uniform. Each will have its own entomological *ad hoc* problems, but it does not necessarily follow that in every case these problems are worth investigating; this will depend mainly on the value of the crops affected. It may be that the natives living in one of these districts grow in a normal year sufficient foodstuffs for their own needs, and in abnormal seasons when, owing to depredations of pests or drought, their crops fail, supplementary supplies can be provided them at relatively small cost; further, that the district, owing either to the nature of the soil or climate, sparseness of population, distance from the sea-port or some other cause, is unsuited to the cultivation of any of the more valuable crops, such as cotton or coffee, yielding an exportable product, and that, in short, no adequate return could be looked for from money expended on the provision of an entomological service. Under such conditions, unless, of course, political reasons warrant it, there is no justification for the employment of entomologists to work on the pests of the district.

Another zone or district, also producing no crops of great value, may in certain years, owing to the ravages of pests, be liable to suffer from famine conditions, when from lack of transport facilities or some other cause there may be considerable difficulty in providing grain from outside. The justification for the provision of an entomological service in such a district is obvious.

In a third zone there may be large areas under cotton or some similar valuable crop grown for export, but the crop is well estab-

lished—that is, it has been grown on a similar scale for many years, and conditions as regards pests may be said to be stabilized. If, as a result of a preliminary survey, it appears certain that the losses due to pests are sufficiently heavy to justify the expenditure of Government funds on an entomological service, then that service should be provided.

Finally, there is the district which at the moment produces nothing beyond the crops required to support the population, and yet is believed to be capable of great development, provided that transport and other facilities can be supplied. Such development will probably consist of the extension of the areas under an existing crop or the introduction of a new crop; in either case, ideal conditions for the pests of the crop will result. The provision of transport and other facilities will call for a large capital expenditure, and it is only after these facilities have been provided, and therefore the capital expended, that the crop can be grown on a large scale. The opening up and development of such an area must of necessity be of the nature of a venture, and every reasonable precaution should be taken to ensure the success of the venture. Supposing the crop it is proposed to grow is cotton: the loss of 50 lbs. of lint per acre due to bollworms, or a depreciation in value of 1d. per lb. of lint due to stainer bugs, might be a very serious matter. The provision of an entomological service under these conditions should not be delayed until pests have caused damage, but should constitute part of the initial programme for the agricultural development of the area.

A decision having been reached as to which districts or zones require an entomological service, the next point for consideration is the composition of such service. Having regard to the duties of an entomologist, as outlined above—it is obvious that a man cannot tour the district and carry out detailed laboratory research at the same time—and also the need for leave in a tropical country, the minimum qualified staff required for a district is, generally speaking, two. Two entomologists based on a conveniently situated laboratory and provided with native laboratory assistants constitute an efficient unit capable of studying the pests of a large area, provided always that the climatic and agricultural conditions generally are similar throughout the area. Two relatively small areas adjoining though differing essentially in climatic and agricultural conditions may be served by three entomologists (two for laboratory research and one for field work) based on two laboratories, one in each area; or again, when a single district produces crops of exceptionally high value, more than two entomologists for that area alone may be required.

The main essentials to be borne in mind are that neither the field work nor the laboratory research should be neglected, and that the staff employed to protect the crops from pests must depend on the value of the crops to be protected.

The direction and co-ordination of the work of the entomologists stationed in the provinces will be the duty of the senior entomologist, with an office at headquarters, where the main collections and records will be kept.

Whether the entomological service as a whole should constitute a department by itself or be a section of some other department, such as the agricultural, medical, or educational, is a matter it is not proposed to discuss, for the reason that, in the writer's opinion, it is of secondary importance. The point of primary importance is the type of official employed throughout the Government service. The writer subscribes to the theory that no form of organization of Government departments will ensure co-operation between officials, nor will any form of organization prevent it, though such co-operation may possibly be facilitated or hindered, to a certain extent, by the nature of the organization adopted. Given that the entomologists, in common with the other officials with whom they come in contact, are working whole-heartedly for the good of the country in which they are serving, there need be no fear that the service will suffer from lack of co-operation.

No mention will be made of medical and veterinary entomology other than to state that, in the writer's opinion, an entomological service such as that outlined above is capable of dealing with all entomological problems whether of a purely agricultural or of a medical or veterinary nature, and that to place all the responsibility for entomological work in the country on the one well-organized entomological section or department makes for efficiency and economy. Given that the one service is made responsible for all entomological work, it follows that the needs of the country from a medical and veterinary standpoint, as well as from the agricultural, must be considered when the strength of the service is being determined.

Apart from the direct return to Government in losses averted for the moneys expended on an entomological service, the work of the applied entomologist has a certain indirect or political value in that it brings him into close contact with the inhabitants of the country. The native must sometimes have difficulty in recognizing the benefits he receives for the taxes he pays; a tribe too weak to protect itself appreciates the protection afforded it by a strong Government, but to the would-be raider the advantages attached to enforced

peace are less obvious. There are certain benefits a Government can provide which undoubtedly appeal to the native; he is keenly alive to the value of a medical service, and pastoral tribes are grateful for the help afforded them by a veterinary service. It is not unusual for petitions to be received from natives asking for protection for their animals or their crops from pests, whether hyenas, birds, or insects; if the entomological service can afford this protection, the value of its work will not be unnoticed.

Received March, 1927.

COTTON STATISTICS—X

WORLD'S CROPS

BY

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It seems desirable that as these statistics are now becoming a regular series they should be arranged in such a way that the same statistics appear each year as nearly as possible on the same date. For the April issue the world's crop statistics seem most suitable, as most of the principal crops are by that time sufficiently advanced to justify at least a preliminary estimate of the outturn. In this issue, therefore, we give the summary table of the world's cotton crops with the detailed tables for the American and Egyptian crops. The Indian table is held back till July, because the final statistics of that crop, especially the southern portion, appear just too late for inclusion in the April issue.

With regard to the smaller crops, in order to make the total tally with the "others" shown in Table I. of the World's Cotton Crops, the Empire crops are also included in summary, but the usual detailed table of these crops will follow in the July issue.

With regard to the world's supply, the point of interest is that 1926 has carried still further the very marked recovery in the world's total supply which has been going on since 1923. 1925 was the first year to show a total in excess of pre-war figures, and 1926 has again established a new record. This is almost entirely due to the rapid recovery of the American crop during the last three years. It was a little doubtful whether 1925 really constituted a new record for that crop, because the apparent increase was largely due to linters, but there can be no question about 1926, which is not only a record for the acreage, as will be seen from Table II., but is also the largest yield per acre since 1914. It shows, in fact, a higher yield per acre than a great many of the pre-war years. This recovery of the American crop is mainly due to the very small damage done by boll weevil during the last three years, but it is too soon yet to say whether that is likely to continue in the near future.

The effect of the big American crop on prices, not only of American but of all other varieties, is the central fact of the situation, and is

likely to have very serious effects on the whole position of Empire cotton. It will almost certainly lead to a reduction of acreage everywhere, and if it lasts long is bound to prove a very serious discouragement to the development of cotton in all the new areas throughout the world which have made such marked progress in recent years.

TABLE I.—THE WORLD'S COTTON CROPS, 1902–26.

BALES OF 500 LBS. (APPROXIMATELY). 000'S OMITTED. LINTERS INCLUDED IN AMERICAN CROP (AS SHOWN IN BRACKETS).

	America.		*Per Cent. of World Total.*	*India.**	*Egypt.*	*Russia.*	*China.*	*Others.*	*Total.*	*Per Cent. on 1914.*
1902–03	10,827	(196)	63	3,367	1,168	342	800	801	17,305	62
1903–04	10,046	(195)	61	3,161	1,302	477	800	751	16,537	59
1904–05	13,680	(242)	66	3,791	1,263	536	756	803	20,829	74
1905–06	10,805	(230)	61	3,416	1,192	604	788	938	17,743	63
1906–07	13,596	(322)	60	4,934	1,390	759	806	1,027	22,512	80
1907–08	11,375	(268)	62	3,122	1,447	664	875	950	18,433	66
1908–09	13,587	(345)	64	3,692	1,150	685	1,000	971	21,085	75
1909–10	10,315	(310)	54	4,719	1,000	663	1,419	950	19,066	68
1910–11	12,006	(397)	55	3,889	1,515	879	2,589	968	21,846	78
1911–12	16,251	(558)	64	3,288	1,485	873	2,552	1,058	25,507	91
1912–13	14,313	(610)	58	4,610	1,507	892	2,298	1,160	24,780	88
1913–14	14,795	(639)	57	5,066	1,537	980	2,303	1,287	25,968	92
1914–15	16,992	(857)	60	5,209	1,298	1,164	2,363	1,154	28,180	100
1915–16	12,123	(931)	57	3,738	961	1,407	2,057	984	21,270	76
1916–17	12,781	(1,331)	58	4,489	1,022	1,110	1,714	1,027	21,143	79
1917–18	12,428	(1,126)	59	4,000	1,262	603	1,863	1,086	21,242	76
1918–19	12,970	(930)	59	3,972	964	420	2,203	1,298	21,827	78
1919–20	12,029	(608)	53	5,796	1,114	274	1,914	1,485	22,612	81
1920–21	13,880	(440)	64	3,600	1,206	121	1,667	1,406	21,880	78
1921–22	8,351	(398)	51	4,485	972	57	1,263	1,311	16,439	59
1922–23	10,370	(608)	52	5,073	1,243	50	1,884	1,502	20,122	71
1923–24	10,808	(669)	52	5,161	1,306	212	1,747	1,745	20,979	74
1924–25	14,525	(897)	55	6,088	1,455	471	1,880	2,093	26,512	95
1925–26	17,219	(1,115)	58	6,038	1,593	733	1,827	2,221	29,631	106
1926–27	*19,868*	*(1,250)*	*62*	*5,500*	*1,500*	*850*	*1,800*	*2,500*	*32,016*	*114*

* 400 lb. bales. Estimates in italics.

TABLE II.—AMERICAN ACREAGE, CROP, YIELD PER ACRE, AND PRICE, 1899–1926.

Season.	*Acreage Harvested* (000's).	*Crop (Running Bales, 000's).*			*Average Yield (Lbs. per Acre) (Ex Linters).*	*Average Price Middling (Pence per Lb.).*
		Cotton.	*Linters.*	*Total.*		
1911–12	36,045	15,553	556	16,109	207·7	6·09
1912–13	34,283	13,489	602	14,091	190·9	6·76
1913–14	37,089	13,983	631	14,614	182·0	7·26
1914–15	36,832	15,906	832	16,738	209·2	5·22
1915–16	31,412	11,068	945	12,013	170·3	7·51
1916–17	34,985	11,364	1,300	12,664	156·6	12·33
1917–18	33,841	11,248	1,096	12,345	159·7	21·68
1918–19	36,008	11,906	910	12,817	159·6	19·73
1919–20	33,566	11,326	595	11,921	161·5	25·31
1920–21	35,878	13,271	429	13,700	178·4	11·89
1921–22	30,509	7,978	382	8,360	124·5	11·37
1922–23	33,036	9,729	591	10,320	141·3	14·92
1923–24	37,123	10.171	640	10,811	130·6	17·66
1924–25	41,360	13,639	858	14,497	157·6	13·76
1925–26	46,053	16,123	1,044	17.167	167·2	10·77
1926–27	47,653	*18,618**	—	—	*187·0*	—

* December Estimate.

TABLE III.—EGYPTIAN AREA, CROP, YIELD, AND PRICE 1914–26.

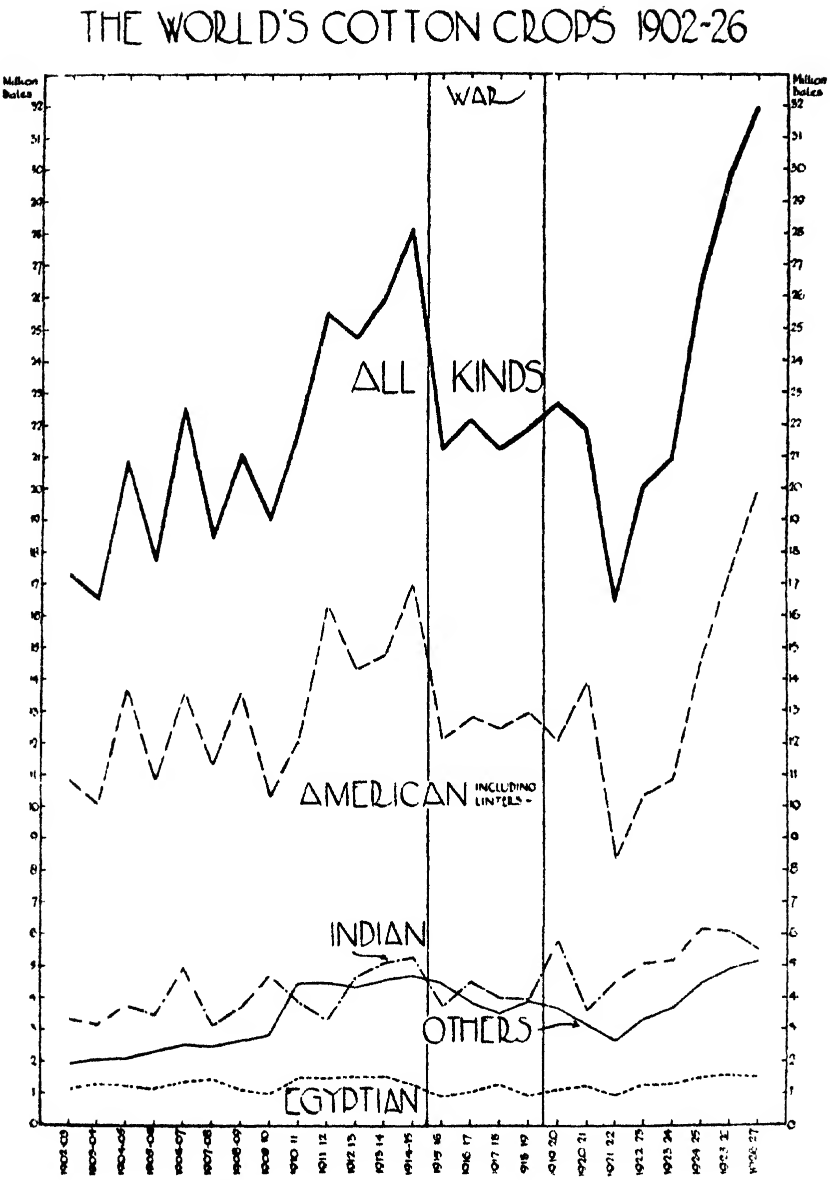
Season.	*Area. Feddans.* 000's.	*Crop Kantars.* 000's.	*Average Yield per Feddan. (Lbs.).*	*Season's Average Prices.*	
				F. G. F. Brown. Pence Per Lb.	*Premium over American Middling. Per Cent.*
1914–15 ..	1,755	6,490	3·70	7·34	40
1915–16 ..	1,186	4,806	4·06	10·42	39
1916–17 ..	1,656	5,111	3·10	21·56	75
				Sakel.	
1917–18 ..	1,677	6,308	3·75	30·97	43
1918–19 ..	1,316	4,821	3·66	27·85	41
1919–20 ..	1,574	5,572	3·54	60·34	139
1920–21 ..	1,828	6,030	3·30	30·24	154
1921–22 ..	1,292	4,858	3·76	19·75	74
1922–23 ..	1,801	6,213	3·45	17·29	16
1923–24 ..	1,715	6,531	3·81	21·55	22
1924–25 ..	1,788	7,274	4·07	29·82	116
1925–26 ..	1,924	7,965	4·14	20·05	86
1926–27 ..	1,786	*7,500*	*4·26*	—	—

TABLE IV.—SUMMARY OF THE SMALLER CROPS, 1914–1926.

In 500-lb. Bales (approximately). 000's Omitted.

	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Persia	131	127	91	72	66	84	73	68	75	91	93	105	*105*
Europe and Asia Minor ..	153	126	132	119	109	128	118	54	65	122	146	245	*260*
Mexico	112	100	106	110	237	203	220	169	186	168	288	198	*379*
Brazil	406	296	341	413	486	552	424	483	519	544	630	606	*650*
Peru	123	115	128	130	136	183	164	183	185	196	193	186	*200*
Other South American ..	14	13	13	19	21	20	56	62	65	146	169	220	*230*
West Indies (British)	5	4	3	2	5	5	4	3	4	3	3	4	*5*
West Indies (Others)	13	15	11	11	12	16	13	22	17	17	18	19	*20*
East Indies, etc.	71	69	77	73	68	90	67	36	26	23	23	24	*25*
Japan and Korea	68	63	63	79	92	118	127	128	205	197	183	190	*200*
Africa (British)	55	53	55	53	60	74	126	83	122	186	266	338	*340*
Africa (Others)	3	3	7	5	6	12	13	18	25	42	67	75	*75*
Australia and Iraq	—	—	—	—	—	—	1	2	8	10	14	11	*11*
Totals	1,154	984	1,027	1,086	1,298	1,485	1,406	1,311	1,502	1,745	2,093	2,221	*2,500*

Estimates in italics.


THE WORLD'S COTTON CROPS 1902-26
Million Bales
WAR
ALL KINDS
AMERICAN INCLUDING LINTERS
INDIAN
OTHERS
EGYPTIAN

NOTES ON CURRENT LITERATURE

COTTON IN INDIA.

151. India's Cotton Problem: Effect of American Prices. (Abstr. from the *Financial Times*, February 15, 1927.) That the Japanese have made progress in India's markets largely because they have increased their purchases of Indian cotton was one of the many interesting conclusions drawn by Mr. H. A. F. Lindsay, C.S.I., C.I.E., I.C.S., the Indian Trade Commissioner, in an instructive paper on "India's Cotton Problem," read before the East India Association at the Caxton Hall on February 14th.

There were two reasons, the lecturer said, why he had chosen India's cotton problem as the subject of his address. First, cotton was the biggest single item in the long list of commodities in which India is interested, both as a producer and as a consumer. The second reason, and a rather wider one, was that we were all interested to-day—whether we are businessmen or economists or merely students—in what he might call world economics.

Of all the world's staple commodities, cotton, in his opinion, was the most interesting, because the development of the cotton trade during and since the war was so typical of our economic development generally. There was first the period when, instead of being respectably spun into yarn and woven into cloth to clothe mankind, cotton was deliberately blown up, not by hundredweights, but by tons, throughout the period of the Great War. Then followed years of shortage, which might almost be described in biblical language as "the years which the locust hath eaten," for successive American crops were devoured piecemeal by the bollweevil, and prices ran up to exorbitant heights.

Fortunately, the great law of demand and supply began to operate. The higher prices went, the more was production encouraged.

Discussing the effect of these changes and vicissitudes of production and price on the Indian crop, Mr. Lindsay continued: India is the next biggest producer of cotton after the United States, but is apt to be rather overshadowed by the American crop, which outnumbers it in most years by three bales to one. This competition of American cotton has always been a feature of the Indian cotton markets. In the case of most other crops, such as wheat or rice, oilseeds, hemp, etc., the various producing countries of the world compete with each other on fairly level terms, and no one can claim absolute supremacy. He was, of course, not referring to monopolies, such as jute, but to the ordinary agricultural crops of the world, where cultivation is not privileged and competition is free.

The first point noticed in a comparison of prices of Indian and American cotton during the past few years was the tremendous rise which occurred owing to war conditions. The second point is the gap that developed between the two levels. Both points had an intimate bearing on India's cotton problem.

The point to note was that Indian cotton prices did not rise in proportion to the rise in American prices. That was chiefly due to the fact that for two or three years in succession India was lucky in having bumper cotton crops at a time when the American crops were short. Although Indian cotton prices were not able to follow American to the same dizzy heights, the loss was made up to India in a larger output.

But there was a further point of interest to note in this connection—namely, that the relative values of American and Indian cotton in the last year or two

had drawn closely to each other. In fact, the margin between the two price levels was much narrower in January, 1927, than at any earlier period, even during the pre-war season 1913-14.

As the great advantage that Indian cotton gives to the Indian mills over foreign mills spinning American or Egyptian cottons is that of cheapness, the effect on the Indian industry when Indian cotton is very close to the price of American cotton, as it is in January, 1927, could be understood. The advantage of cheapness has been reduced to almost nothing, and this point is of the greatest importance to the Indian textile manufacturers.

The depression from which the Indian mills, and especially the Bombay mills are suffering to-day is due to two important factors: first, the margin between the prices of Indian and American cottons is very narrow; and, secondly, as the American cotton prices have fallen the finer goods have, naturally, also fallen in price, and are again coming within the purchasing power of India's middle classes.

But there were other and bigger considerations at stake. The Japanese cotton industry has undoubtedly made tremendous strides since the war. It has used the profits made during the period of high prices to write down capital values, and, in some cases, even to write down the values of stocks of cotton. Labour conditions have also been improved in Japan, and the rates of ocean freight between Japan and India are kept surprisingly cheap. For some years Japan had the advantage of a falling exchange with India, which enabled her to undersell Manchester products on the one hand and Indian products on the other. Finally, Japan undoubtedly secured a considerable advantage from the fact that her cotton-mill operatives—chiefly women—were employed at night, in spite of the terms of the Washington Convention, while India had for many years past prohibited the employment of women on night work in factories. Thus machinery was kept going in Japan for longer hours than was possible in India or Lancashire, and overhead charges were proportionately reduced. It is understood, however, that Japan will enforce this provision of the Washington Convention in her own mills with effect from 1929. It will be some time yet before the Indian mills and handlooms can supply the whole of India's requirements of cotton cloth. It is in the interests of Lancashire to see that everything possible is done to improve the purchasing power of the Indian peasantry and middle classes, whose purchases go so far to maintain the Lancashire mills in employment.

152. Bombay Cotton Annual, 1925-1926, No. 7. A compendium of information and statistics upon all matters connected with cotton in India—such as Crops, Exports, Imports, Prices, Stocks, Consumption, Government Notifications, etc.—that will be absolutely indispensable to all who are concerned with that subject.

153. Indore Institute of Plant Industry. From the Annual Report of the Director for the year ended June 30, 1926, we quote the following in reference to the preparation of organic matter for the cotton crop: " One of the directions in which the yield of cotton can be markedly increased is to supply the soil with fermented organic matter in a finely divided condition. These matters have already been worked out empirically in China and Japan, and are described in King's 'Farmers of Forty Centuries.' All that is needed is to apply this work to Indian conditions and to make use of all existing raw materials. Almost any form of organic matter is suitable for the purpose. The material should be mixed with earth, ashes (when available), a little cowdung (to start the fermentation in the right direction), and water. The final result is a finely divided manurial earth, rich in nitrogen and organic matter. Fresh *san* hemp has yielded a promising product containing 0·97 per cent. of nitrogen, which is now being applied to cotton. Water weed from a local river gave similar results, the compost in this case containing about 0·5 per cent. of nitrogen. The experiments with cotton stalks are

not yet complete. All the weeds and refuse organic matter produced on the Experiment Station are now as a matter of routine converted into valuable manure, and in due course find their way to the cotton fields. There is at present a serious waste of manure going on in India due to the fact that raw unfermented materials are applied to the soil. This practice is incorrect. The soil cannot prepare food materials and grow a crop at the same time; to attempt to make it do so is to overwork the land. The Chinese discovered the secret of avoiding this common mistake. They never overwork their fields, and confine the activities of the soil to its proper function—viz., that of growing a crop. The preparation of food materials for the plant is always done outside the field. The successful introduction of this principle into Indian agriculture would lead to a great increase in the production of cotton. As results accumulate on this subject at Indore they will be published."

154. TIRUPPUR COTTON MARKET. (Abstr. from *Digest of Operations of the Dept. of Agr., Madras*, no. 50, 1926, p. 3.) Each week the current market rates for cotton at the Tiruppur market are quoted in the daily papers. This marketing centre has been built up by the Agricultural Department; fifteen or twenty years ago it was a small country market town, where a small trade was done in Bourbon cotton, now it is the largest market in Coimbatore district, if not in the Presidency. The chief demand is for the better quality cottons—*e.g.*, Cambodia or Karunganni.

155. GOVERNMENT TEXTILE INSTITUTE, MADRAS. (*Ind. Text. J.*, 1926, **36.** Abstr. from *J. of Text. Inst.*, xvii., **11**, 1926, A. 387.) The Government Textile Institute, Madras, which provides training in all branches of the cotton and silk industries, is described. The economic difficulties confronting the Indian handloom weaving industry are discussed.

156. THE POSITION OF THE INDIAN COTTON TEXTILE INDUSTRY. By Y. S. Thakeray. (*Anglo-Gujarati Qtrly. Jour. of the Indian Merchants Chamber*, vol. xix., **2**, 1926, and subsequent number.)

157. COTTON CULTIVATION IN BERAR. (*Ind. Text. J.*, 1926, **34.** Abstr. from *J. of Text. Inst.*, xvii., **11**, 1926, A. 346.) The soil and climate of Berar, Central Provinces, are suitable for growing cotton, which has replaced wheat and millet as a major crop. Cotton would be planted continuously if soil fertility conditions allowed, and land rents are increasing progressively. It is anticipated that there will be a demand for quick-acting artificial fertilizers when once their importance is appreciated by the cultivator. The purchasing power of the Berar growers appears to be well able to meet the cost of fertilizers.

158. IMPROVED INDIAN COTTON. By S. G. Warty. (*Ind. Text. J.*, 1926, **37.** Abstr. from *Summ. of Curr. Lit.*, vi., **23**, 1926, E. 125.) New lines of research to enable cotton-growers to produce longer staple cotton are indicated, with brief references to work already being done at various research stations in India in the branches of cultivation, insect pest control, correlation of spinning tests, and measurable characters of the hair, etc.

159. LENGTH OF FIBRE AND GINNING PERCENTAGE IN INDIAN COTTONS. By R. Prasada. (Abstr. from *Agr. J. of India*, xxi., **6**, 1926, p. 445.) In the course of experimental work on Indian cottons at the Botanical Farm, Cawnpore, both selection and hybridization methods were applied to the various types in order to examine the inheritance of ginning and staple characters. Selection method was employed on a fairly extensive scale and covered three districts, extending to an area of several thousand square miles, and almost every village that grew

cotton was visited, and many thousands of samples were examined each year. Selections from these samples were grown on the farm, and the progeny was studied chiefly in respect of the ginning percentage and staple length. As far, however, as the comparison has been made, it appears to point to the same conclusion, that the correlation is negative, and that as the ginning percentage increases the length of the staple decreases. The coefficient of correlation obtained in different determinations averages at $\pm 0{\cdot}27$, and the small magnitude indicates slightly partial correlation. Briefly tabulated the points are:

1. By the selection method the length of the staple and ginning percentage do not permanently retain their high value. Some increase in one or the other direction is possible, but a definite limit in the combination of their high values is imposed by pure line selection methods of improvement.
2. The hybridization method provides better means for effectually retaining the combination at the high value of the two characters of length of fibre and ginning percentage, and for this reason the crossing method appears more hopeful.
3. A limit in the combination of two characters of the length of fibre and the ginning percentage is decided. (It may be possible to produce a cotton ginning 38 per cent. and having lint capable of spinning 22s.)
4. The degree of the closeness of cotton hairs on the surface of the seed increases with the ginning percentage, the number of fibres per unit area being greater in high ginning ones and fewer in low ginning ones.

160. Punjab's Textile Development. (Abstr. from *Text. Recorder*, xliv., **527**, 1927, p. 96.) The Government is now installing a power-loom factory of 100 looms for demonstration purposes at Shahdara in the neighbourhood of Lahore; this is with a view to the gradual substitution of power looms for hand looms for the local workers.

161. Bhit Shah Cotton Cultivation, Sind. (*Bull. Agr. Dpt., Sind.*, 1923, **113**. Abstr. from *Summ. of Curr. Lit.*, vi., **23**, 1926, E. 125.) The yield per acre for Bhit Shah cotton is higher than for Deshi, and the ginning out-turn is 40 per cent. Owing to its high germination, only 12 lb. of hand-ginned or 20 to 25 lb. of machine-ginned seed of this variety are necessary to give a sufficiently thick stand; usually 40 to 70 lb. of seed per acre are sown.

162. Soil Colloids and the Growth of the Cotton Plant. By A. Howard. (Abstr. from the *Proceedings of the Thirteenth Meeting of the Indian Central Cotton Committee*, 1926, p. 47.) Observation of the cotton crop on the black soils suggests that the formation of soil colloids during the rains is the principal factor which retards growth and limits the yield. This is particularly the case in years of heavy rainfall, when growth is very slow; the plants are stunted, the yield is low, and the bolls open late. At present the grower is at the mercy of the rainfall, and the yield is a matter of chance. What is wanted is to furnish the cultivator with some weapon by means of which the position can be partly or entirely reversed. Perhaps the easiest way of dealing with this problem is to apply a small dressing of a suitable oil-cake in a finely divided condition which will tend to put the colloids out of action and also supply nitrogen in a readily available condition. Karanj cake, a local oil-cake obtained from the seeds of a leguminous tree (*Pongamia glabra*), applied at the rate of five maunds per acre, has greatly improved the vegetative growth, and increased the yield of cotton by more than 25 per cent. The effect on the crop of small dressings is much greater than would be expected from the chemical composition. Crushing in an ordinary mortar mill reduces this cake to the requisite state of division. Plantations of this tree have been started at Indore so as to determine the yield of seed per acre, and the increased cotton crop which can be obtained. The seed contains about one-third of its weight of oil, which is being examined by Dr. Simonsen at the Indian

Institute of Science, Bangalore, with the object of stimulating the trade in this product. It is likely to be suitable for lubrication and for the manufacture of soap. There seems little doubt that a small plantation of this tree will be sufficient to provide manure for a comparatively large area of cotton, and that it will pay the cotton-grower to devote attention to this valuable species. In many parts of the black soil tracts there is ample land for the purpose.

COTTON IN THE EMPIRE (EXCLUDING INDIA).

163. THE IMPERIAL CONFERENCE, 1926. *Extract from the Appendices to the Summary of Proceedings.* (Cmd. 2760.) *Report of Research Special Sub-Committee.* (Section xix. of Cmd. 2768.) In his introduction to the Report, the Right Hon. the Earl of Balfour (Chairman) pointed out that the states of the Empire had such varied economic capacities that to bring out the best results full co-operation was necessary, but that such co-operation could not be imposed from above. The stages through which the applications of science passed were fourfold: (1) the fundamental discoveries in pure science; (2) the discovery that these may be applied to some practical problem; (3) the complete exploration of these possibilities; and (4) the application of the knowledge thus gained to the business of economic production.

In Part I. it is stated that co-operation in research seems to be spreading continually, and there is no doubt that the Bureaux of Entomology, Mycology, and Tropical Medicine have been a great help in this direction. Empire Conferences of those engaged in various lines of work are suggested, as well as organizations for the proper dissemination of knowledge. The Sub-Committee suggests that the Imperial Conference should consider a resolution framed on the following lines:

"The Conference, impressed by the need of—

(1) An active prosecution of research in all fields of applied science;

(2) The fullest practicable co-operation between the organizations respectively responsible for agricultural, fisheries, forestry, medical, and industrial research;

(3) The quick and orderly exchange of the results of research between the various Governments and research establishments of the Empire;

(4) The fullest possible discussion of problems of common interest;

commends Part I. of the Report of the Research Sub-Committee and the suggestions therein contained to the favourable consideration of the respective Governments of the Empire."

The questions of man-power and the shortage of recruits are dealt with in Part II. The shortage is thought to be due to the inadequate appreciation by the public of the value of research, the doubts as to continuity of remunerative employment by the recruits themselves, and other causes.

In Part III. an Imperial Agricultural Research Conference is proposed for October 4, 1927, its main purpose being to work out methods of co-operation in the various branches of agricultural research.

Among other matters in Part IV., an appreciative account is given of the work of the Empire Cotton Growing Corporation, the Sub-Committee recommending that the Imperial Conference should pass a resolution on the following lines:

"The Conference notes with pleasure the success attending the activities of the Empire Cotton Growing Corporation, and commends to the favourable notice of the respective Governments the steps which the Corporation is taking to co-operate with the Administrative and Agricultural Departments concerned in the promotion of cotton-growing within the Empire."

164. SOME PROMISING EMPIRE COTTON FIELDS. By Sir William Himbury. In a paper read before the Royal Colonial Institute, Sir William Himbury gave an account of a tour through India and much of Africa. A description is included of the great new developments in irrigation in Sind and the Punjab, and of the Agricultural Colleges and other institutions of India. A general account of the trip through Africa follows, written in a keenly observant and critical way. All who are interested in Empire cotton should read this paper.

165. THE GROWTH OF THE SOUTH AND COTTON. (*Text. Rec.*, xliv., **524,** 1926, p. 83.) Fear has been expressed that a large crop of American cotton may cause a falling off in activity in Uganda and other Empire centres of cotton-growing. It would indeed be deplorable if such were the case, but we do not fear the contingency. There is every reason why we should persist in our endeavours to increase the volume of cotton other than that grown in America, and we cannot do better than give the most recent figures relating to the growth of the industry in the cotton-bearing states. The latest statistical figures issued by the New Orleans Cotton Exchange show that the increase in Southern cotton mills since 1924 has been 24. The figures are:

1924	998
1925	1,010
1926	1,022

The increase in spindleage has been over 700,000 since 1924, the figures being:

1924	17,194,171
1925	17,642,696
1926	17,909,026

Loom figures are:

1924	318,870
1925	326,222
1926	328,708

As regards consumption, there is an increase of over 700,000 bales between 1924 and 1926:

1924	3,985,328
1925	4,380,118
1926	4,778,926

The consumption per spindle for the 1925-26 season has been 13,083 lb. per spindle. It will be agreed from the foregoing figures that even though the United States has suffered depression, there is a constant and steady increase in spindles, looms, and consumption. A short crop might be fought for by these mills, and therefore we should not slacken our efforts to produce Empire raw material for our spindles.

166. COTTON ABROAD. THROUGH AMERICAN EYES. By E. C. Trout. (Abstr. from the *S.A. Cot. Growers' Journ. and Sub-Trop. Planter.* vol. iii., **5,** 1926, p. 39.) The first sentence of this article states that "The United States still holds the dominant place in the production of the world supply of cotton, and all efforts by European nations to develop cotton production in other parts of the world have not, as yet, offered a challenge to American supremacy," and it is up to our producers, for the sake of stability in prices alone, if for no other reason, to render such a statement a little less correct as soon as may be.

167. EUROPE: MALTA. *Cotton Cultivation.* (Abstr. from the *Bull. of the Imp. Inst.*, xxiv., **4,** 1926, p. 686.) Cotton is grown in Malta as a dry-farmed summer crop, and owing to the favourable spring of 1925, it was grown on a larger scale than in the previous year. The total production in 1925 was 312,840 lb. of lint

from 1,628 acres as compared with 229,328 lb. from 965 acres in 1924. Cotton spinning and weaving, which at one time were flourishing industries in the islands, are now virtually extinct, the number of persons engaged in these occupations, according to the report on the 1921 census, falling respectively from 9,753 and 4,693 in 1851, to 262 and 221 in 1921. Almost the whole crop is therefore exported, the figure for 1925 being about 270,000 lb. (valued at £11,465), which was sent to Italy, the United Kingdom, and the Netherlands. The ordinary Maltese cotton is a form of *Gossypium herbaceum* and has a short staple, but an Upland long-stapled variety introduced by the Department of Agriculture is regarded with favour by growers who have taken up its cultivation.

168. ASIA: CEYLON. *Cotton Production.* A short report received from the Director of Agriculture, regarding the prospects of cotton production in Ceylon at the end of January, contains the following information: "I have just completed a tour of inspection of the cotton-growing areas in the Hambantota district with the Divisional Agricultural Officer. There has, so far, been a shortage of rain during the season, but cotton is looking healthy, and will, if weather conditions this month continue to be favourable, produce crops equal to those secured last year. Progress has been made in the attempt to consolidate cotton cultivation in the hope of securing a greater interest in permanent occupancy and crop rotation, and the experiments in rotations carried out at the Experiment Stations have been successful, and are attracting the attention of progressive agriculturists."

169. IRAQ. *Cotton Cultivation.* (Abstr. from the *Monthly Agr. Bull.*, December, 1926./January, 1927.) The last pickings of cotton were taken in December. Heavy losses to cultivators were caused by the unusual autumn rains; it is, however, expected that the total crop for 1926 will be at least 3,000 bales. Preparations for the anti-locust campaign are being pushed forward.

170. AFRICA: *Road Transport in Africa.* By Col. C. N. French. (Abstr. from *Motor Transport*, November 15, 1926, p. 563.) A detailed discussion of the whole question, with an account of the experiments initiated by the Empire Cotton Growing Corporation.

171. NIGERIA. *Nigerian Cotton.* (Abstr. from *Text. Recorder*, xliv., **527**, 1927, p. 94.) The purchases of cotton for export in the Northern Provinces of Nigeria for the whole of 1926 amounted to 39,411 bales, as compared with 28,096 bales for 1925 and 15,694 bales for 1924. Practically the whole of this cotton is of the improved long-stapled variety, which is suitable for Lancashire trade, and is worth in this country from 1d. to 1½d. over and above the price of American futures. In order to deal with the increased quantities of cotton which are now being produced in the Northern Provinces, the British Cotton Growing Association have established a number of new ginneries in the more important cotton-growing areas, and these will be ready to deal with the current season's crop, which is now being marketed.

172. *Cotton Grading.* (Abstr. from *Rpt. of the Cotton Industry*, 1925-26.) The Director of Agriculture states that the result of the grading of the 1925-26 crop has recently been discussed with the three firms in England who sell most of the cotton from Northern Nigeria. They are all of opinion that the first-grade cotton is extremely even running, and apparently find Nigerian grading, which is carried out on the seed cotton, more efficient than the lint grading which is done in some other colonies.

The grading in the Southern Provinces is said to show a marked improvement on that of the previous year.

173. *Transport in Nigeria.* (Abstr. from *Trop. Agriculture,* vol. iii., **12,** 1926, p. 250.) The completion of the eastern branch of the Nigerian Railway and the linking together of the Eastern and Western systems is described by the Governor, Sir Graeme Thomson, as "a most important landmark in the history of the development of Nigeria." All Nigeria will benefit indirectly by the greater freedom of internal trade which will result. The first and most immediate benefit will be felt in Northern Nigeria, whose staple crops of cotton and groundnuts will now have a second route to the coast, and the choice of two ports, Lagos and Port Harcourt, at the same cost of carriage. Oil-palms, cotton, beniseed, groundnuts, and ginger are already grown along the line of the new railway, and the culture of these valuable products of world commerce will now receive a stimulus which could have been given in no other way.

174. RHODESIA (NORTHERN). *Cotton in Northern Rhodesia.* (Abstr. from the *Int. Cot. Bull.*, v., **18,** 1927, p. 169.) A scheme has now been instituted in Northern Rhodesia under which funds for advances to selected growers are provided in equal proportions by the Government and the Empire Cotton Growing Corporation. Borrowers have to limit their cotton plantations to a maximum area of 50 acres, the advances being fixed at £3 for every acre under cotton, a further advance not exceeding £1 per acre being permissible in special circumstances. As the sanction of the Colonial Office had to be obtained for this scheme, it affords a clear indication of the faith of the Imperial Government in the future of cotton-growing in Northern Rhodesia, a belief evidently also shared by the experts of the Corporation.

175. RHODESIA (SOUTHERN). *Cotton in Rhodesia.* (Abstr. from *Int. Cot. Bull.*, v., **18,** 1927, p. 169.) A report received by mail from Salisbury (Southern Rhodesia), states that the authorities as well as farmers, in Northern and Southern Rhodesia are in no way deterred by the disastrous climatic conditions which prevailed in the last two years, and are proceeding with their plans to establish cotton cultivation in both colonies on a sound foundation. It is recognized on all sides that much better crops could have been secured if the work of experiment in soil and seed selection, insect pests, suitable varieties, and treatment had preceded the decision reached in 1924 to double the area under cotton. Experimental work in all these directions is now in progress, unostentatiously but thoroughly, at the cotton-growing station at Gatooma and various other places throughout Southern Rhodesia Advisers appointed by the Empire Cotton Growing Corporation are greatly assisting the investigations at the Gatooma Station, which is a Government establishment.

176. In a report by W. E. Meade, entitled "A Review of Agricultural Conditions in Southern Rhodesia to November 30, 1926," a copy of which we have received from the High Commissioner, it is stated that the acreage to be planted to cotton this season will be considerably curtailed for a variety of reasons—viz., late rains, two bad seasons in succession, and low prices. The latter is perhaps the chief deciding factor. Farmers are not giving up cotton, but are restricting their activities to smaller acreages. With a few exceptions, planting will be confined to the middle and low veld, where the conditions for cotton cultivation are more suitable.

177. SIERRA LEONE. *Report on the Recent Attempts to establish the Cultivation of Cotton.* (Pamphlet No. 13. Issued by the Lands and Forests Dept., 1926.) The work began in 1923, with the receipt from Nigeria of 5 cwt. of Allen's Long Staple seed, which failed on account of excessive rain and lack of expert supervision. Much the same happened in 1924 and 1925, and it would appear that the future success of cotton cultivation in Sierra Leone must depend upon the

breeding (possibly from the local Quande cotton by crossing) of a type of cotton better suited to the climate.

178. SOUTH AFRICA. *Cotton in South Africa.* From the *Ann. Rpt. of the Secretary for Agriculture*, June 30, 1926, recently received, we quote the following: "Although as yet a comparatively small item in our production compared with other crops, the rapid advance in output, as well as its great potentialities, necessitates special attention to cotton in this report. The 1924-25 crop of 6,774,432 lbs. of lint showed an increase of 77·1 per cent. over the previous season, and with a large increased acreage the 1925-26 crop will, it is hoped, yield some 10,000,000 lb. Further assistance has been rendered by the Empire Cotton Growing Corporation, and the services of their chief officer in South Africa, Mr. Milligan, are gratefully acknowledged.

"In the administration of the levy on cotton, the Department has consulted the Cotton Exchange, with which body it is constantly in touch. The appointment of seed-cotton classifiers has greatly assisted the work of grading, and as a result the numbers of cases of defective packing have decreased considerably.

"Cotton-seed has been produced and distributed from the Rustenburg Experiment Station, and arrangements have been made for multiplying the jassid-resistant strain produced by Mr. Parnell of the Experiment Station at Barberton.

"During last season the Government cotton grader dealt with 15,119 running bales, as compared with 7,270 the season before. As in the case of tobacco, experimental work and extension work were carried on by the divisional officers.

"The future of cotton in the Union may be regarded as decidedly bright, provided that the ravages of insects can be successfully combated. The report on insect enemies contains particulars of what is being done in this respect." (*Cf.* Abstr. 234.)

179. *Cotton Growing. The Problem before the South African Grower.* (Abstr. from the *Sun and Agr. J. of S.A.*, January, 1927, p. 91.) In an interview given to the *Sun and Agr. J. of S.A.*, Mr. A. G. Owen, Manager of the Transvaal Estates and Development Company, points out that for the South African grower to make cotton pay at present prices improvement of yield and of quality is necessary. He suggests that farmers would be wise to reduce their acreage, believing that with the reduction in the planted area, methods of cultivation are likely to be improved, closer observation will be possible on insect movements, and an improved system of handling the crop may be evolved.

180. *South African Cotton Prospects.* By F. M. du Toit. (Abstr. from *Farming in South Africa*, vol. i., 8, 1926, p. 265.) The author states that with the lower prices for cotton ruling to-day, it is imperative that cotton-growers in South Africa pay more attention to the details governing the economic production of this crop to make it a profitable undertaking. There are still large areas in the Transvaal and in Zululand where cotton can be grown under such favourable conditions as to be a paying proposition even at present prices, but here also it is essential that the most efficient and economical methods of cultivation be practised if returns are to be satisfactory. The need for a well-balanced diversified type of agriculture in cotton areas is stressed, the farmer in such areas including cotton in the list of his staple crops, and not depending on it for his sole cash return.

The author concludes by saying it is evident that speculative and spectacular prices for cotton are a thing of the past, consequently the time has come for South Africa to modify her methods accordingly, and to settle down to a steady, businesslike procedure, which will establish cotton upon a firm foundation, and give it an equal place with wool production, citrus growing, or dairying in the category of permanent agricultural enterprises of the country.

181. *Cotton Progress and Problems in South and East Africa.* By Captain S. Davis. (*The Br. and S.A. Export Gazette*, January 7, 1927, p. 55.)

182. *The Railways and the Cotton Industry.* By Sir William Hoy, K.C.B., General Manager, South African Railways and Harbours. (Abstr. from the *Sun and Agr. Journ. of S.A.*, September, 1926, p. 847.) An interesting article giving information under the following heads: Cotton production in the Union; Special development rates for cotton traffic; New railways serving cotton-growing districts; Agricultural potentialities.

183. *Grades of South African Cotton.* (Abstr. from the *S.A. Cotton Growers' Journ. and Sub-Trop. Planter*, vol. iii., **4**, 1926, p. 7.) "A very large number of wool-packs received at the ginneries this season have been found to be badly false-packed—*i.e.*, good, clean seed-cotton is packed with stained, trashy pickings. In such circumstances it is impossible to classify these packs correctly, and most difficult for the ginner to produce a good, even-running lint. It leads to false-packed lint bales being produced, which is most detrimental to our product on the overseas markets. False-packed lint bales are graded on the lowest portion, which is a direct loss to the farmer. The mixing of different staples means a greater spinning loss. Many spinners who have used our cotton complain of this. We lose entirely the custom of some, while others bid reduced prices to counteract the loss. In the end it is the grower who suffers."

184. *Cotton Experimental Work. Investigating Pest Control: How Kynochs are Tackling the Problems of the Cotton Farmer.* (Abstr. from the *Sun and Agr. J. of S.A.*, November, 1926, p. 1084.) Deals with the breeding of jassid-resistant varieties of cotton, fertilizers, ginning, etc.

185. ZULULAND. *Cotton Growing.* (Abstr. from the *S.A. Cot. Growers' J. and Sub-Trop. Planter*, vol. iii., **5**, 1926, p. 29.) A railway line to the Nkwaleni Valley, where so much cotton is being grown, is now being surveyed, and it is understood that as soon as the survey is completed the construction work will be put in hand. The Minister of Lands, when he visited the district, suggested to the cotton growers that they might plant sugar-cane also, so as to be ready with the proceeds when the line is finished. This will probably lead to a demand for the Ntambanana lands, and be of great assistance to those who have had such an unfortunate experience during the flood years. A feeling of optimism prevails in the district, and if the Government can be induced to stabilize the price of seed cotton, it will be the making of the industry here.

186. TANGANYIKA. (Extract from *East Africa*, vol. iii., No. 134, 1927, p. 605.) "We are officially informed from Tanganyika that through low prices much of the cotton is being left on the plants, to be burned now that the end-of-season cleaning is being carried out. This is all the more regrettable in view of the good outturn of high-grade cotton that the favourable season just closing has produced."

187. UGANDA. *Cotton Prospects.* The latest report from the Department of Agriculture states that the prospects are generally satisfactory throughout the Eastern, Buganda, and Northern Provinces.

188. *Cotton Growing in Uganda. The Problem of Better Transport.* (Abstr. from *East Africa*, iii. **114**, 1926, p. 273.) Speaking at a banquet given in his honour by the British Cotton Growing Association, the Hon. W. G. A. Ormsby Gore said that he was of opinion that by taking a long view of the cost of producing the type of cotton which Lancashire wanted, it could, and would, be produced in better quality and more cheaply in British Africa than in any other part of the world. It was mainly a question of transport. Ideal conditions in Africa

were mainly found within the areas between 500 and 1,000 miles from the nearest port, and therefore the whole problem in developing British cotton-growing was that of cheapening transport. The rate of increase in Uganda was not being maintained, not because the natives were not willing, not because land was not there, and not because facilities were not there, but because the lower price made it a non-paying proposition to pick the crop at more than a certain distance from the railway. It was absolutely necessary to carry out, in addition to the railway programme, a road programme and a motor transport programme.

189. *Uganda Budget: Deficit Owing to Cotton Slump.* (Abstr. from *Text. Recorder*, xliv., **527**, 1927, p. 99.) Owing to the slump in the cotton market, the Uganda Budget shows a deficit of £200,000 as the result of reduced receipts from taxes. The surplus balances are being used to balance the Budget, and a committee is being formed to consider economies. As a result of the fall in the prices of cotton, and in order to secure for the native grower in Uganda the highest price possible, so as not to discourage him from continuing production, the railway authorities announce that they are prepared to recommend a reduction of their rates on cotton by 25 per cent., provided that the shipping companies make an equivalent sacrifice and that the Government of Uganda and the merchants make arrangements to ensure that the price paid to the growers approximates to 10 cents per pound.

The *East African Standard* learns from London that the shipping companies and merchants interested in the transport of cotton from East Africa are likely to co-operate with the railway authorities in order to encourage the grower to continue production.

190. AUSTRALIA: QUEENSLAND. Extracts from a letter from Mr. W. G. Wells, Cotton Specialist, Queensland, dated December 14, 1926: "We have been experiencing the worst season since I have been here, and one might say that the whole of Eastern Australia is in the throes of a drought. The spring rains were very poor—nothing of any consequence having fallen until the end of September, when storms of varying intensity fell over most of the cotton areas. Since then, with the exception of the Upper Burnett and portions of the South Burnett, there has been a steady, unbroken spell of cool, dry weather. This past week has seen some chance of a change, as scattered storms have occurred over a wide area, and rain is falling around Brisbane to-day.

Planting was effected following the storms at the end of September, but the lack of rain since then has left the areas around the Rockhampton district practically destitute of cotton. Rains falling now may save the situation there, as the lack of early frosts allows some degree of success to be obtained from late-planted crops. Good strikes were obtained in the Callide Valley, a majority of which have been saved, but the acreage will be smaller there this season than last, due to the fact that there was only one planting rain.

Very little cotton will be raised along the coastal areas from Rockhampton to Bundaberg, with the exception of Boyne Valley, which has about the same acreage as last year, and is in good condition. A portion of the inland coastal areas around the ranges to the west of Bundaberg have gone in for cotton again this season, as the results obtained from cane-growing last season did not compare so favourably as anticipated with those obtained from cotton crops of two seasons ago. A fair acreage is anticipated for such areas, and the early planted crops look well.

The Gayndah line to Eidsvold has had varying climatic conditions this season, but as a whole has been on the dry side. The farmers with early prepared seed beds have been able to obtain good strikes in many areas, and such crops have withstood the drought remarkably well. The recent rains will change the complexion of such plantings very quickly, so that by the middle of January they should be well forward in their fruiting.

The Upper Burnett has come through in splendid shape once more, and certainly appears to be a great cotton district. The crops were put in early, and have made excellent growth. The individual acreages in this district have increased in size this season—thirty to forty acres being quite common. If good results are obtained from this crop, I anticipate that the present acreage—which will be around 4,000 acres—will be considerably expanded next season. If such is the case, the areas will be of such size as to warrant the purchase of the most modern cotton-growing implements. This will enable a considerable reduction in the cost of production to be effected, and if the price of picking can only be brought down to 1½d. per pound, I fail to see how the farmers in this area can afford not to grow cotton.

The Southern areas are affected again this season by the drought, which prohibited an increase in the acreage to be grown. The extremely dry winter and spring has resulted in severe losses of dairy cattle, and if planting rains had fallen, the growers intended putting in fair-sized crops in order to have a chance to recoup some of their losses. Unfortunately the rains have fallen too late for such a short-seasoned district, so the acreage will be the lowest for years.

The same general outline of experiments as developed when Mr. Evans was here has been continued, with some additional studies of problems which presented themselves during the past season. Some new country has been brought under the plough which appears to be exceedingly uniform, and well suited to experimental work.

The value of having a farm like the Research Station has certainly demonstrated itself this season. We have had the most trying climatic conditions since the commencement of the preparation of the seed bed, yet have succeeded in establishing a crop which has not only withstood the extremely droughty conditions, but has developed a fairly decent type of plant, although somewhat stunted. Normal conditions from now on will rectify this, and will enable a good crop to be produced. This result has been obtained by employing methods of preparation of the seed-bed and cultivation of the crop which every farmer could carry out, and with very little more expense than he incurs at present. Fortunately, more of them are adopting our methods every season, so that one can hope to see eventually a decided improvement in the general standard of cultivation in all of the areas."

191. *Agriculture in Central Queensland.* By G. B. Brooks. (Abstr. from *Queensland Agr. J.*, xxvi., **6**, 1926, p. 538.) *Cotton.* The bulk of the cotton crop has been harvested, and although high yields were not obtained, this is practically the only product that has withstood the adverse climatic conditions, and brought in some return to the farmer.

192. *Cotton Growing in Queensland.* By W. G. Wells. (Abstr. from *Queens. Agr. J.*, xxvii., **1**, 1927, p. 33.) Deals with the climatic conditions experienced during the past season; the development of the Callide Research Station; pure seed propagation; experiments; the work of the grading staff; insect pests and diseases.

193. WEST INDIES: ST. VINCENT. The Report of the Agr. Dept. for 1925, recently received, contains descriptions of the manurial experiments with Sea Island cotton (p. 3); cotton selection work (p. 11); work done in connection with the control of the major pests of cotton—*i.e.*, pink bollworm, cotton stainer, and cotton worm (p. 13); the minor pests and diseases (p. 17). In addition, an account is included of the progress made in the cotton industry (p. 19), and of the working of the Government cotton ginnery during the 1925-26 season, which shows a considerable advance on the working of the previous season (p. 42).

COTTON IN EGYPT.

194. THE COTTON CONGRESS IN EGYPT: FINAL RECOMMENDATIONS. (Abstr. from *The Times* of 7/2/27.) The following resolutions have been adopted by the joint Committees of the Congress:

(1) The Congress appreciates the efforts made by the Egyptian Government to issue crop forecasts, and hopes these will be published punctually at the dates fixed previously, and at the same time every year, and also recommends their issue more often than once a month.

(2) The Congress appreciates the work undertaken by the Egyptian Government and the Royal Agricultural Society with the object of increasing the yield per feddan, thereby reducing the cost of production, and also appreciates the legislation whereby the mixing of cotton-seeds becomes a criminal offence. It also recognizes the value of the measures taken for the selection of cotton-seed and the combating of insect pests, and admires the work done by the Cotton Research Board with a view to improving the quality of cotton.

(3) It recommends the formation of a Joint Permanent Committee representing Egypt and the International Cotton Spinners Federation, with seven members each, to consider carefully the problems relating to Egyptian cotton.

As regards spinners' complaints, the Congress urges that spinners shall undertake researches to arrive finally at the natural amount of moisture in cotton, and report on their findings at the next meeting of the Congress, to be held at Barcelona in 1929. Meanwhile, the delegates urge merchants to abolish agreements with reference to the maximum degree of moisture, and also to direct their efforts to the elimination of foreign bodies and mixing in bales.

195. EGYPTIAN COTTON: CAUSE AND EFFECT OF THE EGYPTIAN GOVERNMENT'S INTERVENTION IN THE COTTON MARKET. By the Cairo correspondent of the *Times Trade and Eng. Supplt.* (Abstr. from *Int. Cot. Bull.*, v., No. 18, 1927, p. 202.) Every year since the war, whenever cotton prices have undergone any serious depreciation, there has been an outcry in Egypt for action on the part of the Government to prevent a further drop, and each time the clamour has resounded, the Cabinet in office has obeyed the popular order to buy cotton on the open market. This year, however, notwithstanding the fall in prices, the Government have decided not to intervene as a purchaser, but to assist the grower by making him advances on favourable terms through the banks. Briefly the scheme is as follows: The Government opens a credit of £E.4,000,000 on its reserve for the purpose of making advances through the banks to owners of cotton at a rate of 4 per cent., which may, in some cases, be reduced to 3 per cent., on lots of between 5 and 200 cantars, for a preliminary period of four months, which may be prolonged for a further four months. All expenses connected with the storage and custody of the cotton will be borne by the Government, and the advances will be made on the following basis:

	Fully Good Fair, or Above. £E. Per Cantar.	*Good Fair. £E. Per Cantar.*
Sakellarides	$4\frac{1}{2}$	4
Ashmuni	3	$2\frac{3}{4}$
Other varieties	$3\frac{1}{2}$	$3\frac{1}{4}$

The author is of opinion, however, that the real remedy lies in the hands of the cotton-growers themselves. The relations between landlord and tenant must be adjusted to meet the new conditions created by the return of cotton prices to what may be considered as normal post-war level. Rents and the rate of expenditure are still based on the high cotton prices ruling after the war, and it

is essential that a radical readjustment in rents be made to enable the tenant farmer to obtain a livelihood out of cotton-growing, and in addition a considerable reduction in the scale of living will have to take place. In the latter respect, the fellah as well as the pasha will have to mend his ways, for in the matter of luxuries the former has been in his own way as great an offender.

In conclusion, the author states that although Egypt undoubtedly has before it a period of economic stress which is bound to have its repercussion on commerce and finance, there is no ground for pessimism, and there is reason to believe that, as a result of this crisis the general situation, economic, financial, and commercial, will be purged of its unhealthy factors, and become set on a firmer and more stable basis than hitherto.

196. COTTON CULTIVATION IN EGYPT. (*L'avenir textile*, 1923, **8.** Abstr. from *Summ. of Curr. Lit.*, vii., **1,** 1927, E. 2.) The 1926-1927 acreage is estimated at 1,785,702 feddans, a decrease of 7·2 per cent. on that of last season; a decrease of 13 per cent. is predicted for Sakellarides. Development was retarded by cold and damp nights throughout Lower Egypt. Particulars of fructification, harvesting, classification, and quality of the lint, cultural and ginning yields, and pink bollworm incidence are discussed in relation to the previous year's data.

197. HOW COTTON IS CARTED IN EGYPT. (*Text. Rec.*, xliv., **525,** 1926, pp. 52 and 88.) This is largely effected by horse transport, but cotton cartage by motor lorry is now the subject of experiment.

198. SOME INFORMATION ABOUT THE EGYPTIAN COTTON MARKET, FUTURES, AND SPOT. By G. D. Economou and Co., Alexandria. (Abstr. from *J. of Text. Inst.*, xvii., **11,** 1926, p. 209.) A very useful little handbook, containing a great deal of information about Egyptian cotton in general, and the Alexandria market in particular.

199. SIX COTTON POINTS. (Abstr. from *Text. Rec.*, xliv., **527,** 1927, p. 46.) Some very important points were raised at the Cotton Congress at Cairo by the secretary, Fuad Bey Abaza, who asked the Congress to furnish details:

(1) Regarding the spinners' requirements concerning qualities and quantities of Egyptian cotton.

(2) What they regarded as the reasonable difference between American and Egyptian prices.

(3) The spinners' opinion concerning fluctuations in prices, and whether they were against their interests or not.

(4) Had the Sakellarides a market not influenced by the American crop, and had Upper Egypt cotton, such as Ashmuni, any relation with American varieties or an independent market?

(5) What varieties of cotton were cultivated throughout the world, and which might compete with the Egyptian?

(6) Why the spinners were substituting for Egyptian cotton, cotton from other countries, and the present extent of this substitution.

COTTON IN THE UNITED STATES.

200. COTTON ACREAGE REDUCTION IN AMERICA. By V. P. Lee. (Abstr. from *Int. Cot. Bull.*, v., **18,** 1927, p. 199.) The author states that too much increase in acreage has invariably followed a period of high cotton prices; likewise reduction has invariably come after a crisis such as the present. Some method of regulation is needed whereby the extremes of too small or too large acreages can be avoided, and it is suggested that, "If the Farm Bureau Cotton Associations,

or the State Departments of Agriculture, or the Federal Department of Agriculture could arrange to supply information on what cotton farmers as a whole are doing each week just before and during the planting season, each farmer could have some basis for deciding how many acres he wants to plant with cotton. This central organization could also make a practice of collecting general information on the conditions of the cotton market. For instance, from 1921 to 1923, cotton prices went up steadily in spite of the larger acreage and production, due largely to the improved business conditions in European markets."

The author concludes by saying that "the farmer's situation cannot be 'fixed' for him; he must do the fixing himself, and if timely information is made available to him he will fix it. At present he plants a large or small acreage largely on the basis of his memory of a high or a low price received the year before. But last year's price has little to do with that of the coming year. He must have information on the present crop."

201. THE ECONOMICS OF THE COTTON INDUSTRY IN THE U.S.A. By C. T. Main and F. M. Gundy. (*Mech. Eng.*, 1926, **48.** Abstr. from *J. of Text. Inst.*, xviii, **1,** 1927, A. 42.) A broad economic analysis of the problems of the cotton industry in the northern and southern states, dealing with cotton consumption, output, hours of operation, wages and efficiency of operatives, supply of operatives, exports and imports, cost of manufacture, conditions adversely affecting the industry in the recent past, and available remedies.

202. THE AMERICAN COTTON INDUSTRY. By J. S. Dodd. (*Trop. Agriculture,* iv., **2,** 1927, p. 24.)

203. GINNERIES IN AMERICA. (*Manch. Guard.* Abstr. from the *S.A. Cot. Growers' Journ. and Sub-Tropical Planter*, vol. iii., **5,** 1926, p. 50.) The United States Department of Agriculture has just completed a study of cotton-ginning operations and methods in the American Cotton Belt. So far the inquiry has been confined to North Central Texas, but conditions there may be considered as representative of the greater part of the belt. The investigation shows that there has been during recent years a great decrease in the number of ginning plants in the Southern States, but that the size of individual plants is now larger than formerly. In 1912 there were 28,358 ginning plants in the cotton belt, but there were only 18,262 in 1925.

204. CLIMATIC ASPECTS OF COTTON-GROWING IN SOUTHERN ILLINOIS AND MISSOURI. By W. E. Barron. (Abstr. in *Exp. Sta. Rec.*, lv., **3,** 1926, p. 210.)

205. REPORT ON MISSOURI COTTON EXPERIMENT FIELDS, 1925. By B. M. King. (*Missouri Sta. Circ.*, 141, 1926. Abstr. in *Exp. Sta. Rec.*, vol. lv., No. 2, 1926, p. 133.)

206. COTTON PRODUCTION IN TEXAS. By L. P. Gabbard and H. E. Rea. (*Texas Sta. Circ.* 39, 1926. Abstr. from *Exp. Sta. Rec.*, vol. lv., **5,** 1926, p. 483.) The more outstanding facts relative to the growth and development of the cotton industry in Texas are set forth in this circular. The area, soil, climate, acreage, yields, and dependability of crops are described for the four principal cotton-growing areas of the State. Possibilities for future expansion in acreage are discussed.

207. "SNAPPED" COTTON: SPINNING TESTS. (*Text. World*, 1926, **70.** Abstr. from *Summ. of Curr. Lit.*, vi., **22,** 1926, E. 121.) American official tests indicate that the spinning quality of "snap" cotton does not differ materially from that of "picked" cotton, but that "snapping" as a method of harvesting lowers the grade, the difference amounting to about two grades. The decreased cost of harvesting by the "snap" method may be much more than offset by the extra expense of passing cotton through boll extractors and by the loss of value resulting from the lower grade.

[*Cf.* Abstract 53 of vol. iii.]

208. AMERICAN TEXTILE NOTES. By W. Whittam. (Abstr. from *Text. Rec.*, xliv., **524**, 1926, p. 97.) The Cotton Textile Merchants Association of New York has set two men to work developing facts about the cotton industry, primarily for the purpose of assisting the Department of Agriculture in gathering data to inform the cotton-grower in the uses of his product. So far something like 10,000 uses for cotton products have been listed.

COTTON IN FOREIGN COUNTRIES.

209. We have received from the Association Cotonniere Coloniale a copy of Bulletin No. 77.

210. COTTON CULTIVATION AND SPINNING IN ALGERIA. (*L'avenir textile*, 1926, **8**, 6. Abstr. in *Summ. of Curr. Lit.*, vii., **1**, 1927, E. 1.)

211. THE COTTON TRADE OF ARGENTINE. By E. L. Tutt. (Abstr. from *Int. Rev. of the Sci. and Pract. of Agr.*, vol. iv., No. 3, 1926, p. 714.) The Cotton Commerce Division of the Ministry of Agriculture has published a propaganda book with the purpose of promoting the co-operative sale of cotton.

212. COTTON CULTIVATION IN BOLIVIA. (*Manch. Guard. Coml.*, 21/x/26 Abstr. from *Summ. of Curr. Lit.*, vol. vi., **20**, 1926, E. 98.) A British Syndicate has secured a large concession in the Gaiba district of Bolivia, and it is intended to develop 200,000 acres for cotton; already 600 acres have been cleared and planted. Railway construction has commenced, and a steamship service between Gaiba and Buenos Ayres has been instituted.

213. BULGARIAN COTTON INDUSTRY. (Abstr. from *Text. Recorder*, xliv., **525**, 1926, p. 110.) Cotton and cotton goods represent nearly a quarter of the value of the imports into Bulgaria. The Government is now endeavouring to increase the production of cotton, and it is hoped that this season's crop will amount to a million kilograms (4,000 bales).

214. THE COTTON PROBLEM AND FRENCH WEST AFRICA. By H. Bloud. (Abstr. from *Exp. Sta. Rec.*, vol. lv., No. 4, 1926, p. 335.) This treatise deals with the cotton question in the French colonies in Africa, discussing the problem from political, economic, geographical, and agricultural viewpoints. Summaries of the results of different experiments with the crop in several colonies are included.

215. COTTON IN ITALIAN SOMALILAND. (Abstr. in *Summ. of Curr. Lit.*, vi, **22**, 1926, E. 120.)

216. JAPAN. *Report on the Cotton Spinning and Weaving Industry*, 1925-26. By W. B. Cunningham. (Recently received from the Dept. of Overseas Trade.) An invaluable summary of the present position in Japan, pointing out the increase in production and export that is going on, and the increased competition to be expected.

217. PARAGUAY. CLASSIFICATION OF COTTON. (Abstr. from *Int. Rev. of the Sci. and Pract. of Agr.*, vol. iv., No. 3, 1926, p. 720.) Legislation has been passed by the Government providing for the creation of a State Department for cotton classification, and for fixing the grades of cotton in bale ready for exportation.

218. COTTON CULTIVATION IN PERU. By O. B. G. Tafur. (*Rev. App. Ent.*, 1926, **14**, Ser. A., p. 545.)

219. COTTON CULTIVATION IN SPAIN. (*The Times*, Spanish number, 10/8/26, Abstr. in *Summ. of Curr. Lit.*, vol. vi., **20**, 1926, E. 104.)

CULTIVATION AND MACHINERY: IRRIGATION.

220. COTTON SEED. VIABILITY. By G. F. Lipscomb and T. I. Dowling. (*Science*, 1926, **64**. Abstr. from *Summ. of Curr. Lit.*, vol. vi., **20,** 1926, E. 111.) The authors show that when cotton seed is heated in hydrogen the percentage of germination is very low, and the plants are less vigorous than those of the untreated seeds. The hydrogen-treated seeds were extracted with ether and iodine numbers determined by the Hubl method. These ranged from 82 to 99 as compared with 104-115 for the untreated seeds, showing that the unsaturated oils formerly present in the seeds had become partially saturated. Further experiments were made in which the tube containing the cotton seed was connected with a very sensitive manometer. At the end of thirty hours' continuous heating, the movement of the mercury pellet indicated the absorption of hydrogen by the oils. Nitrogen was similarly studied; with one exception, a germination of less than 50 per cent. was obtained, and the germinated seeds were less vigorous than the untreated seeds. The iodine numbers varied from 105 to 109. In the manometer apparatus the mercury pellet, after the first three or four hours of heating, was blown out of the tube, indicating a decomposition of the proteins or other vital constituents. Enzyme action, as with hydrogen, appeared to be normal. A decomposition was also noticed with carbon dioxide, but it was much slower than with nitrogen. At the end of thirteen hours of heating in carbon dioxide no germination was obtained.

221. YOKING OXEN TO THE PLOUGH. A NEW SYSTEM. By W. S. H. Cleghorne. (*Science Bull.*, No. 53, Dept. of Agr. Union of South Africa. Obtainable from the Govt. Printing and Stationery Office, Pretoria, S.A. Price 3d.)

222. RIDGE CULTIVATION OF COTTON. By B. M. Desai. (Abstr. from the *Agr. J. of India*, xxi., **5,** 1926, p. 377.) Experiments in different methods of ridge cultivation without manuring gave an increase of 24·4 per cent. seed cotton. The combined effect of ridging and manuring resulted in an increase of 42·6 per cent. seed cotton. Ridging methods should be employed in districts with a high rainfall. Descriptions are included of the methods of preparing ridges and of the implements used.

223. COTTON FERTILIZER EXPERIMENTS. 1921-25: DELTA BRANCH STATION. By W. E. Ayres. (*Miss. Sta. Bull.*, **234,** 1926. Abstr. from *Exp. Sta. Rec.*, vol. lv., No. 4, 1926, p. 334.) Fertilizer experiments with cotton included trials of the form, rate, and time of application of nitrogenous fertilizers, tests of complete fertilizer, and co-operative tests. Ammonium sulphate and sodium nitrate with cottonseed meal led in average increases, but the ammonium sulphate was the cheapest nitrogen source at current prices. The safest and most economical rate for sodium nitrate appears to be from 150 to 200 lbs. per acre, applied half at the time of planting and the remainder at the second cultivation. Considering experimental results and experience, nitrogenous fertilizers used alone seem most economical for the Delta, except along the foothills and on soils in which cotton either rusts or wilts badly. On such soils potash is needed. Decided increases were made by cotton following soy beans.

224. HOW THE CHEMIST HELPS THE FARMER. By C. O. Williams. (*Farming in South Afr.*, vol. i., **8,** 1926, p. 283.)

225. PLANT NUTRITION AND CROP PRODUCTION. By Sir John Russell. Published by the University of California Press, Berkeley, California. Price $2½, and obtainable also from Camb. Univ. Press, 12s. 6d. net. (Abstr. from *Agr. Jour. of New South Wales*, xxxvii., **12,** 1926, p. 878.) Under the above title

are presented the Hitchcock Lectures in the University of California for 1924, delivered by Sir John Russell, Director of the Rothamsted Experimental Station, Harpenden, Hertfordshire. The titles of the five lectures afford an indication of the field covered: (1) The Study of Plant Nutrients; (2) Positive Science and Exact Demonstration; (3) Decay and the Living Plant; (4) The Soil Micro-organisms: Can they be controlled and utilized ? (5) The Soil and the Living Plant.

226. Field Crops Experiments in Georgia, 1925. (*Georgia Sta. Rpt.*, 1925. Abstr. from *Exp. Sta. Rec.*, vol. lv., No. 2, 1926, p. 131.) Lone Star, Delfos, and Acala led the cotton varieties during a very dry season. Since on removing weeds with a hoe there was produced 804 lbs. of seed cotton, with three cultivations 731 lbs., and with six cultivations 634 lbs., cultivation probably depressed yields. Slow-acting forms, such as cotton seed, peanut meal, and velvet bean meal, produced the highest yields among various sources of nitrogen. A small increase was obtained where cotton was top-dressed with sodium nitrate and ammonium sulphate at planting time, while a small decrease resulted when the application was made at chopping time or when the plants were squaring. Further determinations verified previous data, showing that sulphur preserves both the organic and the inorganic nitrogen in compost mixtures. The percentages of oil in cotton seed and the acre production of cottonseed oil by twenty-five varieties and strains are tabulated.

227. Cotton Varieties. By T. S. Buie. (*Clemson Agr. Col. S.C., Ext. Circ.*, 75, 1926. Abstr. from *Exp. Sta. Rec.*, lv., **3**, 1926, p. 230.) The significance of earliness, wilt resistance, and lint length in cotton varieties is indicated briefly, and based on experiments at the South Carolina Experiment Station and the experience of farmers in the State. Cleveland cotton is recommended for short staple production on wilt-free land, and Dixie Triumph on wilt-infested land, and Lightning Express, Deltatype Webber, or Carolina Foster for long-staple production.

DISEASES, PESTS, AND INJURIES, AND THEIR TREATMENT.

228. Boll Weevil Control by Airplane. By R. J. Wilson. (*Congr. Rec.* 67, 1926, **40.** Abstr. from *Exp. Sta. Rec.*, vol. lv., No. 3, 1926, p. 258.) In this account the author deals particularly with the successful application of calcium arsenate in the control of the boll weevil, especially during the season of 1925. The success met with by a commercial dusting corporation during the season of 1924, when about 1,000 acres of cotton near Greenville, Mississippi, were dusted, led to a large extension the following year. During the season of 1925 this company dusted 50,000 acres of cotton.

229. Recommendations regarding Boll Weevil Work. By J. E. Mills. (*J. Econ. Ent.*, xix., **4**, 1926. Abstr. in *Rev. Appl. Ent.*, vol. xiv., **10**, 1926, p. 534.)

230. Boll Weevil in Oklahoma, especially during the Years 1921 to 1925. By C. E. Sanborn. (*Oklahoma Sta. Bull.* 157, 1926. Abstr. in *Exp. Sta. Rec.*, vol. lv., No. 2, 1926, p. 158.)

231. The Arizona Cotton Boll Weevil Problem. By T. P. Cassidy. (*J. Econ. Ent.*, xix., **5**, 1926. Abstr. from *Rev. Appl. Ent.*, vol. xiv., **12**, 1926, p. 654.) The Arizona boll weevil (*Anthonomus grandis thurberiæ*, Pierce) is a variety specially adapted physiologically to thrive in arid regions, and has for its food *Thurberia*, or wild cotton, which is found throughout the south-western portions of Arizona. In two counties it has already attacked cultivated cotton, to which it is a serious menace. Field tests have shown that weevils taken from *Thurberia* readily infested cultivated cotton, and caused considerable damage. It is thought that this weevil may be potentially a more serious menace to cotton in the drier

regions than either the Pink Bollworm (*Platyedra gossypiella*, Saund.) or the typical *A. grandis*, Boh. are in the regions in which they occur. For one thing, the Arizona weevil prefers bolls for oviposition, so that measures to make a crop mature in advance of the weevil, such as are employed in the south against the typical form, would be of no advantage. Again, this weevil shows a very high degree of resistance to extreme conditions, and is able to go into a state of at least partially suspended animation whenever conditions become unfavourable, and it can maintain this for a very long period. Hibernation studies showed that about 70 per cent. of the weevils survived under conditions about as severe as are ever expected in the district, whereas only 2 to 5 per cent. of *A. grandis* survive under normal conditions. Moreover, this variety is ideally adapted for transportation. A high percentage of individuals of the last generation in the autumn form very hard cells in the cotton seed or lint, and most of these are gathered with the picking. They go through the gin easily, and many of them will be carried along with the lint and introduced into the bales of cotton. It is suggested that some definite action should be taken to prevent the Arizona boll weevil from becoming established in cultivated cotton, as approximately one-sixth of the normal cotton crop of the United States is produced in the western area, where *A. grandis* cannot thrive sufficiently to cause any damage, and it would seem possible to double this production within the next few years, provided that the territory remained free from insect pests.

232. NORTHERN TERRITORY, AUSTRALIA: ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE. By M. C. Goode. (Abstr. from *Rev. Appl. Ent.*, vol. xiv., **10**, 1926, p. 523.) *Platyedra (Gelechia) gossypiella*, Saund., is the most serious pest of cotton in the Northern Territory of Australia. It should be possible to control it by adopting special precautions at the ginnery and the application of winter fallow and crop rotation. Peanuts (*Arachis*) are suggested as the most suitable rotation crop.

233. AN IMPORTANT QUEENSLAND INSECT PEST. By R. Veitch. (Abstr. from the *Queensland Agr. Journ.*, xxvi., **5**, 1926, p. 385.) A description of a species of *Nysius* which has caused serious losses in Queensland, and is found to attack not only cotton, but other plants, such as the potato, cherry, tomato, grapes, mango, etc.

234. COTTON PESTS IN SOUTH AFRICA. From the *Ann. Rpt. of the Sec. for Agr.* for the year ended June 30, 1926, recently received, we learn that investigations into cotton pests have been continued, the employment of the additional staff needed for this purpose being rendered possible by the contribution of funds by the Empire Cotton Growing Corporation, and, with the consent of the South African Cotton Exchange, from the cotton export levy. The Sudan and American bollworms, which have proved serious pests, have received particular attention. As a result of the vigorous campaign against locusts, the prospects of keeping this pest entirely under control are bright. The total cost of the campaign amounted to £217,000.

235. THE COTTON FLEA HOPPER.—I. CONTROL OF THE COTTON FLEA HOPPER IN TEXAS.—II. By H. J. Reinhard. (Abstr. from *Rev. Appl. Ent.*, vol. xiv., **12**, 1926, p. 629.) The first of these papers contains a detailed account of the life-history of *Psallus seriatus*, Reut. (Cotton flea hopper), all stages of which are described, with recommendations for its control; the second paper is a summary of the first.

The author has obtained the following information as the result of his laboratory investigations into the life-history of *P. seriatus*. During the summer months the life cycle from egg-laying to the emergence of the adult varies from 16 to 29 days, the average during May being 22½ days. The adults mate and begin to oviposit usually 3 to 4 days after emergence; both mating and oviposition normally

take place at night. In captivity, adults live for 14 to 29 days, and egg-laying continues for 7 to 18 days, 1 to 3 eggs a day being usually laid; in the field, these periods are probably considerably longer. The nature of the food, as well as temperature, affects the development of the nymphs; nymphs fed on croton leaves became adult in 13 to 20 days, while others fed on the heads became adult in 9 to 14 days. The adults take flight when disturbed, and both nymphs and adults are able to jump; they feed mainly on the tender growing points of the plants, but do not feed at one spot for long. Most nymphs and adults are killed by cold before November 15, and overwintering eggs may be laid as early as September 1, although others may hatch in November.

The damage caused by *P. seriatus* is frequently not uniform; excessive shedding of squares may take place early in the season, when there appear to be few insects, while later in the season, in other fields where the insects are fairly abundant, few squares may be affected; apparently normal plants may be closely associated with others showing every characteristic of injury; sometimes a badly affected plant may recover sufficiently by the end of the season to bear a normal crop on its upper part. For these and other reasons the theory has been put forward that *P. seriatus* transmits a virus, which is actually responsible for the injury to cotton.

Natural enemies are of little importance in controlling the pest. The most important control measures consist of the destruction of weeds that serve as food-plants, the ploughing in of cotton stalks during the autumn or winter, and dusting with sulphur or sulphur-naphthalene, both of which give excellent results, the latter being slightly more effective but more expensive and difficult to obtain.

A list of thirty-eight plants on which *P. seriatus* has been found feeding in Texas is included.

236. COTTON HOPPER CONTROL. By H. G. Good. (Abstr. from *J. of Econ. Ent.*, vol. xix., **6**, 1926, p. 869.) During the present season the cotton hopper (*Psallus seriatus*, Reut.) has been a very serious pest in Alabama, and for the first time noticed in this State. The damage is caused by the insect feeding on the very small squares as they are forming, causing them to fall, thus materially reducing the crop. With the reduction of the squares the plants assume a very rank growth, growing much taller and straighter, and the number of bolls is very few. In many cases the bottom crop, which is the heaviest producer, has been almost entirely destroyed, as well as a good portion of the middle crop.

Sulphur has been recommended by the Texas and other experiment stations, and has given good results. With this in mind, S-Dusting Mixture, put out by the American Cyanamid Company, was tested. This mixture was composed of 50 per cent. calcium cyanide. The cyanide content was between 17 and 25 per cent. This was applied for two reasons, namely, to determine the effectiveness of the mixture for controlling the cotton hopper, and to determine whether burning of the foliage took place. Two tests were applied, and it was found that S-Dusting Mixture was a good control medium for the cotton flea hopper, the application of from 8 to 10 lbs. once a week proving the most satisfactory. It was also found that no burning of the foliage resulted from the application of the cyanide compound.

237. THE COTTON HOPPER, OR SO-CALLED "COTTON FLEA." By W. D. Hunter. (*U.S. Dpt. Agr., Dept. Circ.* 361, 1926. Abstr. from *Rev. Appl. Ent.*, vol. xiv., **12**, 1926, p. 631.) This is an account of investigations of the cotton hopper, *P. seriatus*, Reut., and the injury that it causes to cotton, made in Southern Texas in 1923 and 1924. Of the control measures tested the most satisfactory was sulphur dust, which did not injure cotton plants even when applied in very large

quantities. Its effectiveness was greatly reduced by diluting it with flour or kieselguhr. Dusting with nicotine sulphate, free nicotine, or calcium arsenate had some effect, but spraying with Bordeaux mixture or potassium sulphide had little or none.

238. Report of Work in Entomology at the Texas Station. (*Texas Sta. Rpt.*, 1925. Abstr. from *Exp. Sta. Rec.*, vol. lv., No. 4, 1926, p. 353.) Studies by Thomas and Reinhard of the life-history of the cotton hopper (*Psallus seriatus*), previously reported from Texas, Georgia, and South Carolina, are considered to have been the most important work of the year. In cage experiments, in which 10,000 adults and 3,000 nymphs were used, it was found that the nymphs obtained from horsemint caused more injury than nymphs obtained from croton. Where the nymphs lived and were recovered in the cheesecloth sacks, the terminal bud which would produce a leaf was almost invariably injured, and similar injury could also be produced by confining adults under lantern globes. The life-history may be briefly stated as follows: When laying eggs the female pierces the plant tissue of the tender stems by means of her ovipositor. In the laboratory a maximum of 11 eggs were laid during a twenty-four hour period. The maximum number produced during the life of a single pair was 34 eggs. They are laid singly. The egg stage averages 7·8 during the active period, varying from 6 to 11 days. There are five instars, or nymphal stages, of which drawings have been made. The average length of each nymphal period varies from 1·5 to 2 days in summer. Complete development from hatching to adult stage occurs in from 7 to 10 days, but in fall may require 5 to 6 weeks. The generations are not distinct, as there is great overlapping. In control work it was found that the best results in dusting were obtained with substances containing sulphur.

239. The Cotton Worm in the West Indies in 1926. (Abstr. from *Trop. Agriculture*, iii., **12**, 1926, p. 246.) The cotton worm, the larva of the moth *Alabama argillacea*, was unusually abundant during the 1926 cotton season in St. Kitts, Montserrat, Antigua, and St. Vincent. So far as is known, this pest does not live in the West Indies from one season to another, and it is believed that the attacks are the result of invasion by the moths by flight from South America. The direction of flight, so far as recorded, is northward. At the end of the cotton-growing season in the United States the moths fly away to the north, and they have been seen in great numbers in the northern states and in Canada. These flights have not been noted in the West Indies, but it is believed that the impulse to fly north from Brazil in the first instance, and into Canada in the last instance, will always be the flight impulse. The insect is not known to feed on any other plant but cotton.

240. Gryllus Desertus, Pall., as a Pest of Cotton. By V. V. Lezhava. (Abstr. from *Rev. Appl. Ent.*, vol. xiv., **10**, 1926, p. 508.) Damage to cotton of an unusual type, noticed on the experimental farm in Turkestan in 1925, was found to be due to *Gryllus desertus*, Pall. In all cases the cotyledons and leaves had been eaten into.

241. Crickets as Pests of Cotton. By Z. S. Rodionov. (Abstr. from *Rev. of Appl. Ent.*, vol. xiv., **12**, 1926, p. 608.) During 1925 crickets were responsible for the failure of a proportion of the cotton seed sown by May 31 in Mugan, Transcaucasia. The young seedlings were attacked near the root, and so weakened that they could not penetrate the top layer of soil, about 15 per cent. having died from the injury. An egg found inserted in one of the plants resembled those of *Gryllus burdigalensis*, Latr. *G. burdigalensis* var. *cerisyi*, Serv., and *G. desertus*, Pall., were both found in the field; the eggs of the latter are laid in cracks in the ground. Both species are concerned in the injury to cotton seedlings; they prefer humid places, and occur in abundance on the wing at night from the end

of May to the end of July. Besides cotton, they do considerable damage to *Sesamum orientale*, and also feed on Convolvulus. Fields in which cotton oil-cake was used as a fertilizer recovered best from the injury, this material being probably more attractive than the plants themselves.

242. GRASSHOPPERS IN MISSISSIPPI. (Abstr. from *Rev. Appl. Ent.*, **14**, 1926, Ser. A., p. 476.) The most injurious species of grasshopper is *Melanoplus differentialis.* When attacking cotton, the pest can be controlled by dusting with calcium arsenate.

243. SUR LES OXYCARENUS NUISIBLES AUX COTONNIERS, AVEC LA DESCRIPTION D'UNE ESPECE NOUVELLE. By G. Horvath. (*Bull. Soc. Ent., France,* 1926, Nos. 11-12. Abstr. from *Rev. Appl. Ent.*, vol. xiv., **11**, 1926, p. 558.) Notes are given on the distribution of the known species of *Oxycarenus* that are pests of cotton, namely, *O. hyalinipennis*, Costa, *O. exitiosus*, Dist., *O. saniosus*, Motch., and *O. biocolor*, Fieb., and a new species, *O. gossypii*, is described from Cochin China and Formosa. It is allied to *O. hyalinipennis*, the Formosan form differing somewhat from that from Cochin China.

244. SIERRA LEONE: REPORT ON THE ENTOMOLOGICAL SECTION, 1925. By E. Hargreaves. (Abstr. from *Rev. Appl. Ent.*, xv., Pt. 1, 1927, p. 22.) During the year under review many cotton plants were severely attacked by a leaf-miner, the larva of the moth *Acrocercops bifasciata*, Wlsm.

245. THE QUESTION OF CONTROLLING "CHOR" OF COTTON. By B. P. Uvarov. (Abstr. from *Rev. Appl. Ent.*, vol. xiv., **10**, 1926, p. 508.) The condition of cotton known in Armenia as "chor" is presumably chiefly due to the activities of *Tetranychus.* Experiments with sulphur dust for the destruction of the mites have not apparently been very successful, and it is suggested that improved cultural methods and general strengthening of the plants might greatly reduce infestation.

246. ENTOMOLOGICAL WORK AT THE LOUISIANA STATIONS. By W. E. Hinds *et al.* (*La. Stas. Rpt.*, 1925. Abstr. from *Exp. Sta. Rec.*, vol. lv., **5**, 1926, p. 455.) In cotton plant louse control work it was found that, when the pest threatened to become serious, an immediate application of a combination of 0·5 lb. of nicotine sulphate (40 per cent. nicotine), with 8 lb. of calcium arsenate used as the carrier for the nicotine, applied during periods of still air, gave excellent results. The name Calarnic Dust has been given to this mixture.

247. PESTS OF COTTON IN THE AZERBAIJAN AND NAKHICHEVAN REPUBLICS, TRANSCAUCASIA, IN 1925. (Abstr. in *Rev. Appl. Ent.*, vol. xiv., **12**, 1926, p. 609.)

248. COTTON PESTS IN THE NAKHICHEVAN REGION, AND THEIR CONTROL IN 1925. By I. I. Evstropov. (Abstr. in *Rev. Appl. Ent.*, vol. xiv., **10**, 1926, p. 508.)

249. A FURTHER CONTRIBUTION TO OUR KNOWLEDGE OF THE BIONOMICS AND CONTROL OF THE MIGRATORY LOCUST, *Schistocerca gregaria*, FORSK. (*peregrina Oliv.*), IN THE SUDAN. By H. B. Johnston. (Wellcome Trop. Res. Lab., Ent. *Sect., Bull.* 22, 1926. Abstr. from *Rev. Appl. Ent.*, vol. xiv., **11**, 1926, p. 571.) Only the northern half of the Anglo-Egyptian Sudan is liable to invasion by *Schistocerca gregaria*, Forsk., and the higher humidity of the southern provinces does not appear to favour its breeding. The question of the sources whence the invading swarms come to the Sudan remained open until recent observations demonstrated that the swarms may be formed locally from scattered locusts in their solitary phase. It has been proved definitely, both by observations in the field and by breeding experiments, that the locust known as *S. flaviventris*, Burm., is only a solitary phase of *S. gregaria*, as already suggested by Uvarov. The characters of the two phases are described, the solitary phase differing completely

both in the external appearance of the immature stages and in its habits of life. The transformation of the solitary phase into the swarming one occurs by a gradual change through two or more successive broods. This process can be reversed by the adoption of suitable control measures, as happened in the Red Sea Province in 1926, when the incipient swarms of the migratory phase were thinned out by the application of poison baits, and the scattered survivors turned back to the solitary phase.

250. A CHANGE IN THE METHOD OF CONTROLLING THE ASIATIC LOCUST. By V. Nevskii. (Abstr. from *Rev. Appl. Ent.*, vol. xiv., **12**, 1926, p. 611.) This method of controlling the Asiatic locust (*Locusta migratoria*, L.) is based on its instinct to follow the line of least resistance. A deep pit (not more than 70 feet long) with perpendicular walls is dug at some distance in front of the advancing locusts; a road is then made by continual trampling of men and horses, leading directly from the locusts to the pit. Similar paths are also made diagonally, each leading into the main road. The locusts are thus led on to the main road and into the pit, where they are buried as the pit gets full. This method is much cheaper than the old one, in which a much longer trench was dug to receive the advancing swarm, and is even cheaper than the poison bait method.

251. COTTON INSECT PESTS: CONTROL. By A. H. Lees. (*Ann. App. Biol.*, 1926, **13**, 506-515. Abstr. from *Summ. of Curr. Lit.*, vi., **22**, 1926, A. 58.) The author suggests that a study of the relationship of internal conditions in plants to endurance against insect attack would be a profitable field for research. Fourteen cases are cited, in which host plants have been modified in insect endurance; for instance, the red cotton bug on *Hibiscus cannabinus* at Pusa was found to follow the destruction of fine roots, and boll weevil attack in Texas was checked by a sufficiently raised temperature attained by spacing the cotton plants far enough apart for the sun to reach them freely. It is assumed that changes in external factors have their counterpart in changes in internal conditions in the plant.

252. CHLOROPICRIN: A BIBLIOGRAPHY, WITH SPECIAL REFERENCE TO THE USE OF CHLOROPICRIN AS AN INSECTICIDE (1848-1925), compiled by R. C. Roark. (*U.S. Dept. Agr.*, *Bur. Chem.*, *Chem. Bibliog.*, 1 (1926), pp. 73. Abstr. from *Exp. Sta. Rec.*, lv., **6**, 1926, p. 554.) This is an annotated bibliography of 287 titles in mimeographed form. An index is included.

253. THE LIME SULPHUR-CALCIUM ARSENATE SPRAY. By W. Goodwin and H. Martin. (Research Department, S.E. Agricultural College, Wye, Kent.)

254. A QUANTITATIVE EXAMINATION OF THE TOXICITY OF 3:5-DINITRO-O-CRESOL AND OTHER COMPOUNDS TO INSECT EGGS, UNDER LABORATORY AND FIELD CONDITIONS. By C. T. Gimingham *et al.* (Abstr. in *Rev. Appl. Ent.*, vol. xiv., **10**, 1926, p. 514.)

255. COTTON LEAF DISEASE: NIGERIA. By G. H. Jones and T. G. Mason. (*Ann. Bot.*, **40**, 1926, Abstr. from *Summ. of Curr. Lit.*, vii., **1**, 1927, E. 4.) The paper contains an account of two rather obscure diseases of the cotton plant in Nigeria. The name "Leaf Curl" has been retained for a disease which is especially prevalent on the indigenous species of cotton (*G. peruvianum*, *G. vitifolium*); it is found also on *G. hirsutum*. The histological modifications that characterize Leaf Curl show a striking resemblance to the abnormalities that accompany virus diseases. It has been found that the disease can be transmitted by budding. Infection has not been obtained by inoculation with the sap of diseased plants, nor by jassids. The incidence of Leaf Curl is particularly pronounced in the spring.

The term "Leaf Roll" is suggested for a disease discovered on American cotton (*G. hirsutum*), on which it is more prevalent than on the indigenous species. The under surface of leaves affected by Leaf Roll present a glazed appearance. Microscopic examination shows that some of the cells of the lower epidermis are collapsed. The collapsed cells leave a thick brown deposit. It has been shown that the disease is not infectious. The most important predisposing environmental factor is excessive soil humidity *per se*. Diseased plants produce normal foliage on the onset of dry conditions.

256. EXPERIMENTS IN COTTON ROOT-ROT CONTROL. By C. J. King and A. R. Leding. (*U.S. Dpt. Agr., Dpt. Circ.* 372. Abstr. from *Exp. Sta. Rec.*, vol. lv., 5, 1926, p. 446.) Experiments in progress from 1920 to 1924, in which manure and alfalfa were added to spots where cotton had been killed by root-rot, are said to have shown a reduction in the extent of the infected areas where organic materials were applied, and the reduction was maintained during the succeeding years. Formaldehyde solution applied to diseased areas is reported to reduce the amount of disease, but it is considered to offer little hope as a control measure except where small isolated spots of infection occur on a valuable piece of land.

257. COTTON WILT FUNGUS. (Abstr. from the *Sci. Rpts. of the Agr. Res. Inst., Pusa, India*, 1925-26, p. 62.) At the request of the Special Cotton Mycologist, Bombay, an investigation into the temperature relationship of the cotton wilt fungus, *Fusarium* sp., was undertaken by Mr. M. Mitra. The fungus was grown at 20° C., 25° C., 30° C., 35° C., and 40° C., on both agar and liquid media. The result of the experiment showed in both cases that the maximum growth was between 25° C. and 30° C., and the thermal death point near 40° C.

258. INOCULATIVE EXPERIMENTS WITH NEMATOSPORA GOSSYPII. ASHBY AND NOWELL. By R. W. Marsh. (*Ann. Bot.*, **40**, 1926, p. 883.) In a previous investigation (*cf.* Abstr. 124, p. 72 of vol. iii.) the discoloration in a sample of diseased cotton from Nyasaland was found to be due to a yellow substance in the central canal of the hairs, and it was suggested that *Nematospora* was responsible. Inoculations were tried with *N. gossypii*, etc., on various kinds of cottons, including Webber, Sea Island, Ashmouni, and Sakel. No infection resulted from cultures placed on unwounded bolls, and puncture inoculations were only successful after the boll was two weeks old, when they frequently produced the discoloration in the hairs. Many other fungi and bacteria, however, produced similar results.

259. A PRELIMINARY REPORT OF SURVEYS FOR PLANT DISEASES IN EAST CHINA. By R. H. Porter. (Abstr. from *Rev. Appl. Mycol.*, v., **11**, 1926, p. 656.) Anthracnose of cotton (*Glomerella gossypii*) is very common on American varieties of cotton in East China, the native varieties being apparently less susceptible.

260. PLANT DISEASES AND PESTS IN HAITI. By H. D. Barker. (Abstr. from *Rev. Appl. Mycol.*, v., **9**, 1926, p. 538.) Cotton bacterial rot has caused severe damage to the bolls in wet seasons. They become soft, watery, and rotted at almost every stage of growth, finally turning brown or black while remaining attached to the plants. No control measures have as yet been found satisfactory.

A cotton mosaic, frequent on native varieties, is under study, especially in relation to varietal resistance and the environmental factors that affect the disease, the nature of which is obscure.

261. ASPERGILLUS NIGER. NITROGEN ASSIMILATION. By G. Klein *et at.* (*Z. Physiol. Chem.*, **159**, 1926, 201-234. Abstr. from *Summ. of Curr. Lit.*, vi., **22**, 1926, A. 59.) A detailed study of the mechanism of nitrate assimilation in *Aspergillus niger*, conducted on the principle of accumulation and identification of intermediate products. With a potassium nitrate-nitric acid substrate,

amino-acid and ammonia were formed, but no trace of nitrite formation could be detected. In alkaline medium, however, nitrite was detected in small quantities in addition to amino-acid and ammonia. Amino-acid always preponderated. A consideration of the two methods leads to the conclusion that accumulated intermediate products appear in reverse sequence to the sequence of their formation, and do so in consequence of excess accumulation of amino-acid hindering the forward action. The reduction of nitrate to amino-acid takes place in the medium outside the hyphæ. The addition of such different sources of carbon as cane sugar or glucose shifts the point of maximum amino-acid congestion, and the above assumptions are confirmed. Experiments with ten other moulds gave similar results, and it is concluded that nitrate assimilation in fungi, as in higher plants, is by way of nitrite, ammonia, and amino-acid. Kostytschev's experiments are criticized as being carried out under abnormal conditions for fungal growth.

262. ASPERGILLUS NIGER. GROWTH. (1) By R. Bonnet *et al*; (2) By E. F. Terroine and R. Bonnet. (*Bull. Soc. Chim. Biol.*, 1926, **8,** 970-981. Abstr. from *Summ. of Curr. Lit.*, vii., **1,** 1927, A. 4.) (1) The mycelium growth of *Aspergillus niger* was studied on dextrose-salt media containing various sources of nitrogen and compared with the nitrogen metabolism. The efficiency was 0·61 for asparagine, 0·58 for ammonia and amino-acids, and 0·53 for nitrates.

(2) When dextrose was replaced by malic, citric, or tartaric acid as the sole source of nutrient carbon in the medium, the efficiency of growth fell from 0·58 to 0·53. The reduction of the organic acids to dextrose does not, therefore, require much energy, and the low efficiency of the utilization of protein for growth must be attributed to the energy lost in the metabolism of the nitrogen, since only a small part seems to be required for the conversion of the deaminized residues into sugar.

263. SINGLE FUNGAL SPORE: ISOLATION. By H. N. Hansen. (*Science*, **44,** 1926, 384. Abstr. from *Summ. of Curr. Lit.*, vi. **22,** 1926, A. 60.) A method of obtaining single-spore cultures of species of *Fusarium* is described. A piece of soft glass tubing is drawn to an internal diameter slightly greater than that of the spore to be isolated. The prepared capillaries are broken up into lengths of about 3 cm. and filled by capillary attraction from a spore suspension made in warm nutrient agar. It is possible to obtain one to four spores to the tube. The tubes are examined under the microscope and broken so that each portion contains one spore only. The fragment is removed with forceps, immersed in alcohol to sterilize the outside, and placed in the desired medium. A single hypha is obtained by cutting off the germination hypha emerging from the tube.

264. FUNGAL CULTURES: MOUNTING. By W. F. Bewley. (*Ann Appl. Biol.*, **13,** 1926, 577-9. Abstr. from *Summ. of Curr. Lit.*, vi., **22,** 1926, A. 59.) The fungal culture grown on a suitable agar or gelatine medium is killed by placing a filter paper moistened with formaldehyde in the lid of the petri dish, and leaving the closed dish inverted over night. The agar is dissolved, and the fungal growth floated off into boiling water and further steamed until freed from agar. The growth is then floated on to a piece of glass and allowed to dry, after which it is covered with a second sheet of glass and bound like a lantern slide. Details are given.

265. PLANT PATHOLOGY AND PHYSIOLOGY. (*Texas Sta. Rpt.*, 1925. Abstr. from *Exp. Sta. Rec.*, vol. lv., No. 4, 1926, p. 345.) In continuation of previous studies, additional data were secured relating to the cotton root rot, its hosts, and control. Experiments are said to indicate that more than four years' clean fallow are necessary to destroy the fungus in the black lands of Texas, hence ordinary rotations will not control the disease.

BREEDING, GENERAL BOTANY, ETC.

266. Study of Off-type Plants of Acala Cotton. By R. D. Martin. (*U.S. Dpt. of Agr., Circ.* 390, 1926.) In a study of the progenies of off-type plants selected from fields of Acala cotton in Arizona, the divergent characters were found to be inherited. The series of off-type plants used in the experiments are grouped for purposes of description into a few classes or types, with reference to habits of growth and other characters covering most of the diversities appearing commonly in the Acala variety.

The experiment included progenies grown from plants that were off-type in leaf, stalk, and fruiting-branch characters, such as open, long-jointed plants, close, short-jointed plants, and cluster plants, with brachytic fruiting-branch internodes. Also a series of progenies was studied to note the inheritance of small bolls, short and sparse lint, and various seed characters, including dark fuzz, green fuzz, and naked seeds with little or no fuzz.

Many of the progeny rows appeared surprisingly uniform, considering that they were grown from open-pollinated seed. Usually the resemblance of the off-type character or characters noted in the parent selection was very apparent in the progeny. However, several progenies were extremely diverse, and it was evident that they were of hybrid origin.

The information presented will make clearer the need of careful and continued selection in cotton, and also will assist in the recognition of off-type plants in the roguing of fields where seed is grown for planting.

267. New Cotton Species. (Abstr. from *Text Recorder*, xliv., **525**, 1926, p. 109.) Baron Surcof, the delegate from Portuguese East Africa to the African Cotton Conference (international and inter-colonial) held at Nairobi in 1926, gave a description of a new and promising species of wild cotton which he had found in three different districts in Mozambique. He ascribed an Indian origin to the species, and previous cultivation, but thereafter reversion to a wild form. Baron Surcof was of opinion that with scientific cultivation a useful strain might possibly be developed from it; he informed the Conference that he would continue experimenting, and would communicate results to members at any time. It was deemed important that other delegates should also experiment, and a resolution was taken accordingly.

268. Recent Work on Measurable Characters of the Cotton Hair. By Dr. S. C. Harland. (Abstr. from *Trop. Agriculture*, iv., **1**, 1927, p. 8.) A long and careful review of Miss G. G. Clegg's work on the above subject, carried out at the Shirley Institute.

269. The Relationship between the Concentration of the Soil Solution and the Physiochemical Properties of the Leaf-Tissue Fluids of Egyptian and Upland Cotton. By J. A. Harris. (*J. Agr. Res.* [U.S.), **32**, 1926, No. 7. Abstr. from *Exp. Sta. Rec.*, vol. lv., No. 2, 1926, p. 126.) Continuing studies of previous investigations, an examination was made of the homogeneity or heterogeneity of the field in which the plants were grown, and the influence of soil salinity upon the various characteristics of the plants.

Statistical analysis of the data showed further evidence of the existence of substratum heterogeneity with respect to physical factors of the soil in very small experimental plats, and it is possible to determine in quantitative terms the correlation coefficient of the relationship between the physical and chemical properties of the soil of different portions of the field and the character of the crop produced therein.

The author claims that since the relationship between soil properties and plant characteristics can be measured in terms of correlation and be expressed by a regression curve, it may be possible in the future to predict more precisely

than is now possible the character of the crop which would be produced by a field of given characteristics in a normal year.

270. NUTRIENT SOLUTION: COMPOSITION. By R. Zinzadze. (*Ber. Deutsch Bot. Ges.*, **44**, 1926, 461-470. Abstr. from *Summ. of Curr. Lit.*, vi., **22**, 1926, A. 60.) The author gives the composition of a new nutrient solution which has a pH value remaining constant within the limits 5·3 to 3·8 over a growing period of five weeks. This was the optimum nutrient solution for the growth in length of rootlets of *Zea mais*. The new solution is compared with nine other standard nutrient solutions as regards composition, pH range, and nutritive properties for maize seedlings.

271. COTTON PLANT: CORRELATION OF CHARACTERS. By T. H. Kearney. (*J. Agr. Res.*, **33**, 1926. Abstr. from *Summ. of Curr. Lit.*, vii., **1**, 1927, A. 2.) The paper brings together in a convenient form all available information regarding the correlations existing among the characters of the bolls, seeds, and hair of cotton. Recent work carried out in Arizona includes the computation of the coefficients of correlation on 224 individual bolls borne by fifty plants of Pima Egyptian cotton in 1925 for all possible combinations of the characters seed-cotton weight per boll, hair weight per boll, lint percentage, lint index, number of seeds per boll, mean weight of the individual seeds, boll length, boll diameter, and boll index, a total of thirty-six pairs of characters.

272. COTTON PLANT: TRANSPIRATION. By W. G. Alexandrov. (*Bot. Centr.*, **150**, 1926. Abstr. from *Summ. of Curr. Lit.*, vi. **20**, 1926, A. 54.) A rise in the transpiration coefficient was observed in annual plants in which the vascular bundles of the leaf are surrounded by a well-defined "chlorophyll sheath." All these plants contain oil in seeds or other organs (*Sesamum indicum*, *Gossypium hirsutum*). The significance of fats for plants with higher transpiration coefficients will be discussed subsequently.

CO-OPERATION.

273. PROGRESS IN CO-OPERATION IN SOUTH AFRICA. (Abstr. from *Farming in S.A.*, vol. i., **9**, 1926, pp. 301 and 362.) The report of the Superintendent of Co-operation shows that the various co-operative societies in the Union are generally in a satisfactory position. The value of the cotton sold by the Barberton Cotton Co-operative Co., Ltd., in 1925 was £32,644. Membership increased by fifty-five during the year. Eleven different agricultural and cotton organizations are affiliated to the South African Co-operative Cotton Exchange. This body handled 4,100 bales of cotton during the season, of which 2,724 were sold locally and the remainder shipped to Liverpool.

CHEMISTRY AND PHYSICS IN THEIR RELATION TO COTTON PROBLEMS.

274. THE APPLICATION OF THE SJOSTROM MACHINE TO THE FINISHING OF COTTON FABRICS. By R. Sansone. (*Text. Rec.*, xliv., **525**, 1926, p. 71.)

275. BLEACHING, DYEING, PRINTING, AND FINISHING OF COTTON. Based on the work of M. P. Lederin. Translated, largely rewritten, and Anglicized by J. Ferguson. (*Text. Rec.*, xliv., **525**, 1926, p. 65.)

276. NEW METHOD OF MEASURING COTTON FIBRES. By E. E. Chandler. (Abstr. from *Text. Recorder*, xliv., **524**, 1926, p. 40.) The method described by the author consists in cutting a middle portion, or section, from several pulls of cotton

and determining the ratio by weight of the two ends to the middle. The device for doing this consists of a simple wallpaper cutter and a double straight-edged bar accurately machined to known width, hinged at one end to a block of about equal length. At the other end it is fastened after the cotton is in place by a wing nut, hinged to the opposite end of the block. The bar is sufficiently rigid to withstand considerable pressure when screwed down, and thus serves to hold the cotton securely in place. Between the block and the straight-edged bar is a brass plate. This is left movable, so that the wallpaper cutter will not always run in the same place and establish a groove, which might cause the cutter to deviate from the straight-edge. Various methods of clipping out the middle have been tried, Mr. Chandler reports, but this simple device has proved to be the most practical. By keeping the lower portion of the cutting wheel wall against the lower portion of the straight-edge, a perfectly smooth and even cut is obtained. Ratios approaching 1 are declared desirable from the standpoint of accuracy and convenience, and a straight-edge ⅜ inch wide (or 1 centimetre) gives a ratio approaching unity for the greater part of the cotton crop.

277. Cotton Hair: Length and Diameter Correlation. By R. Y. Winters and P. J. Naude. (*N. Carolina Agr. Exp. Sta. Rpt.*, 1924. Abstr. from *Summ. of Curr. Lit.*, vi., **22**, 1926, A. 57.) The results of a study of the relation between length and diameter of cotton hairs show that as the length increases the percentage of lint and the diameter of the hair decreases. The correlation between length and diameter of hairs in the case studied was $0{\cdot}2929 \pm 0{\cdot}03560$. The correlation between length of hairs and percentage of lint was $0{\cdot}2650 \pm 0{\cdot}03621$. Increase in size of seed was found to be slightly associated with longer hairs. The correlation between these two characters was $\pm 0{\cdot}11303 \pm 0{\cdot}03845$.

278. Cotton Hair Breaking Load: Diameter. By R. Y. Winters and J. B. Cotner. (*N. Carolina Agr. Exp. Sta. Rpt.*, 1924. Abstr. from *Summ. of Curr. Lit.*, vi., **22**, 1926, A. 57.) Considerable differences were found in the average diameters and tensile strength of a number of cotton hairs of the five varieties, Cleveland Big Boll, Mexican Big Boll, King, Cook, and Rowden. There was a direct relation between diameter and tensile strength, the varieties with the broader hairs having the greater breaking load. Mexican Big Boll, with the greatest diameter, 22·576 microns, gave the greatest breaking load, 54·54 decigrams. The respective figures for Cleveland Big Boll were 18·836 microns and 31·43 decigrams. The correlation between hair diameter and tensile strength for all varieties was $0{\cdot}623 \pm {\cdot}013$, showing a positive relation.

279. Cotton Seed Coat Hair Population: Density and Convolutions Correlation. By R. Y. Winters and T. C. Chang. (*N. Carolina Agr. Exp. Sta. Rpt.*, 1924. Abstr. from *Summ. of Curr. Lit.*, vi., **22**, 1926, A. 57.) Increased density of hair population on the cotton seed coat is definitely associated with increased number of convolutions per inch. Increased length was found to be associated with decrease in number of convolutions per inch. The basal half of the hair had fewer convolutions than the other half.

280. Cotton Seed Coat Hair Population: Development. By R. Y. Winters and L. I. Henning. (*N. Carolina Agr. Exp. Sta. Rpt.*, 1924. Abstr. from *Summ. of Curr. Lit.*, vi., **22**, 1926, A. 58.) The density of cotton hair population on the seed coat was determined by cutting out a section of the seed coat of known area with a sharpened leather punch and counting the number of hairs attached to it. The results of a number of determinations showed that as the hair population increased, the hair diameter, the lint index, and percentage of lint increased, and the length of hair and weight of seed decreased. Decrease in length was associated with increased diameter.

281. Effect of Sunlight on Cotton. By G. Barr and I. Hadfield. (*Rpts. and Memoranda of the Aeronautical Res. Ctte.*, No. 1016, H.M. Stationery Office, 1926. 1s. net. Abstr. from *Nature*, February 12, 1927.) It has been found that the determination of the viscosity of a solution of cotton in cuprammonium hydroxide forms a much more sensitive method of following the deterioration in sunlight than that used in the past, namely, the change in tensile strength. After exposure the cotton shows increased reducing properties, and it is evident that chemical and not merely physical change has taken place, although further work on fabric exposed in the absence of oxygen is necessary before it will be possible to decide to what extent the change in the fabric is an oxidation process.

282. The Moisture Relations of Cotton: The Absorption of Water by Cotton Mercerized with and without Tension. By A. R. Urquhart. (*Shirley Inst. Memoirs*, vol. v., December, 1926.)

283. Comparison of the Effects of Oxidation Before and After the Mercerization of the Cotton Fibre. By E. Knecht and E. F. Muller. (*J. Soc. Dyers and Col.*, **42**, 1926. Abstr. in *J. of Text. Inst.*, xvii., **11**, 1926, A. 357.)

284. Mildew in Cotton Goods. Antiseptics and the Growth of Mould Fungi on Sizing and Finishing Materials. By L. E. Morris. (*Shirley Inst. Memoirs*, vol. v., December, 1926.)

285. The Effect of Humidity on Cotton Yarn: (i) The Strength and Extensibility of Sized and Unsized Warp Yarns in Equilibrium with Steady Atmospheric Conditions. By F. T. Pierce and R. J. Stephenson. (*Shirley Institute Memoirs*, vol. v., 1926.)

286. Tensile Tests for Cotton Yarns: The Rate of Loading (Addendum). By E. Midgley and F. T. Pierce. (*Shirley Inst. Mem.*, vol. v., 1926.)

287. Animalized (Amidated) Cotton: Recent Work on the Subject. (Abstr. from *Text. Rec.*, xliv., **524**, 1926, p. 67.) Amidated cotton has affinity for basic as well as acid dyestuffs, and so combines the dyeing properties of wool and silk.

288. Detection of Mercerized Cotton. By C. E. Mullin. (*Text. Colorist*, **48**, 1926. Abstr. in *J. of Text. Inst.*, xvii., **11**, 1926, A. 376.)

289. Cotton: Physiological Properties of, and their Relation to Bleaching and Dyeing. By H. C. Roberts. (*Text. Colorist*, 1926, **48**. Abstr. from *J. of Text. Inst.*, xvii., **12**, 1926, A. 390.) The wax, pectins, natural colouring matters, and tannins present in raw cotton are discussed.

290. Cotton Plant Non-Volatile Constituents: Isolation. By F. B. Power and V. K. Chesnut. (*J. Amer. Chem. Soc.*, 1926, **48**. Abstr. from *Summ. of Curr. Lit.*, vol. vi., **20**, 1926, B. 121.) The non-volatile constituents of dried lateral branches of the cotton plant were examined in detail. From an alcoholic extract of the dried material, after steam distillation, a dark-coloured aqueous liquid and a black, oily resin were obtained. From the former the following were isolated: potassium nitrate and potassium chloride, quercetin, betaine, choline, and succinic acid. From the resinous product were obtained a phytosterol, a phytosterolin, pentatriacontaine, an acid of phenolic character, a mixture consisting of valeric, caproic, and butyric acids, and other substances described.

291. Cotton: Oil Spraying. (*Times Tr. and Eng. Supp.*, **17**, **1926**, 464. Abstr. from *J. of Text. Inst.*, xvii., **12**, 1926, A. 393.) The results of oiling cotton are explained, and the method of applying the oil is described.

292. Raw Cotton: Oil Spraying. Texas Textile Association. (*Cotton*, **90**, **1926**. Abstr. from *J. of Text. Inst.*, xvii., **11**, 1926, A. 350.) A reported discussion.

Two spinners stated that the cardroom and carding machinery were cleaner when the cotton was sprayed, but that in the spinning-room a condition described as a "snowstorm" prevailed. A third spinner stated that he applied the oil by means of a humidifier head. He found that fly was reduced, and static electricity in the cardroom eliminated; he did not observe the "snowstorm" condition, nor any change in the breaking load of the yarn. A fourth speaker found that, whilst fly was reduced, he did not get a good web from the card.

293. COTTON SPINNING: INTERMEDIATE. By T. Thornley. (Published by Ernest Benn, Ltd. Price 25s. net. Abstr. from a review in *J. of Text. Inst.*, xvii., **12**, 1926, p. 235.) This book is a clear, full, and practical treatise on the middle processes in cotton spinning, and is undoubtedly an advance on any of the author's previous works. It merits the reward of being in the hands of those engaged in the trade, and can be thoroughly recommended.

294. AN IMPROVED METHOD OF BLEACHING COTTON WITH PERMANGANATE. (*Text. Recorder*, xliv., **524**, 1926, p. 63.)

295. SOIL COLLOIDS: DETERMINATION. By G. J. Bouyoucos. (*Science*, **44**, 1926. Abstr. from *Summ. of Curr. Lit.*, vi., **22**, 1926, A. 63.) The colloidal content of a soil can be determined in fifteen minutes by the hydrometer method; 50 grams of soil, after dispersion with a pestle and mortar, are placed in a tall cylinder, adding water to a total volume of 1050 c.c. The mixture is shaken vigorously for two minutes, a hydrometer is placed in the mixture, and the density measured in grams per litre. It has been found that the percentage of the material, based on the original sample taken, that stays in suspension at the end of fifteen minutes, is equal to the percentage of the colloids as found by the heat of wetting method. Out of thirty-one soils only three gave discordant results, and these were abnormal soils, which refused to stay in the disperse condition, or which contained incompletely decomposed organic matter. The error in such abnormal cases was not greater than 10 per cent.

MISCELLANEOUS.

296. PROPERTIES OF THE COLLOIDAL SOIL MATERIAL. By M. S. Anderson and S. Mattson. (*U.S. Dpt. of Agr., Dpt. Bull.*, 1452, 1926.)

297. THE STEEPING PROCESS: THE CONSTITUENTS OF COTTON SOLUBLE IN WATER OR DILUTE MINERAL ACIDS, AND THE EFFECT OF THEIR REMOVAL ON SUBSEQUENT SCOURING. By R. G. Fargher, and M. E. Probert. (*Shirley Inst. Memoirs*, vol. v., December, 1926.

298. THE PRODUCTION OF COTTON. By G. H. Collings. (John Wiley and Sons, New York. Chapman and Hall, Ltd., London.) This is an excellent elementary textbook for all who are concerned in any way with the cultivation of cotton. It deals clearly, in a readable style, with the climatology of cotton, and the soils of the American cotton belt; with the structure and classification of cotton, its cultivation, manures, diseases, and insect pests; with its harvesting, ginning, baling, marketing, etc.; with its breeding, its by-products, its feeding value, and production. The book is furnished with many illustrations, and contains at the end useful tables of statistics. It can be recommended to the notice of all Empire cotton-growers.

299. SERVICES IN COTTON MARKETING. By A. B. Cox. (*U.S. Dpt. of Agr., Dpt. Bull.*, 1445, 1926. Obtainable from the Government Printing Office, Washington, D.C. Price 10 cents per copy.) A useful publication dealing with the questions of preparation of cotton for marketing, standardization, classing, assembling, distributing, warehousing, financing, and co-operation.

300. Cotton Futures: What they are and how they work in Practice. By Charles Stewart. (Liverpool, 1926.) A revised edition of this most useful little book has just appeared.

301. Cotton: Partial List of Publications in English. Compiled by E. B. Hawks. (*U.S. Dept. Agr., Libr. Notes*, 1, 1926, No. 6, Sup., p. 12. Abstr. from *Exp. Sta. Rec.*, lv., **6**, 1926, p. 530.) This mimeographed compilation lists about 100 books and pamphlets, and also indicates the publications of the U.S. Department of Agriculture and other Government agencies concerned with cotton. Works on diseases and pests, and publications of the State Experiment Stations are not included.

302. The American Section of the Lancashire Cotton Industry, and Necessity Cotton Fabrics. By E. E. Canney. (*Text. Rec.*, xliv., **527**, 1927, p. 47.)

303. The Raw Cotton Position. By Professor J. A. Todd. (Abstr. from the *Text. Rec.*, xliv., **526**, 1927, p. 77.) A lecture given to the British Association of Managers of Textile Works. Careful statistics of the American cotton crop and the world's cotton crops are included.

304. A Survey of the Cotton Industry. By F. Nasmith. (Abstr. from the *Text. Recorder*, xliv., **526**, 1927, p. 37.) In a lecture delivered to the Wigan Textile Society Mr. Nasmith deals with the following subjects: The supply of the raw material; the question of the increased consumption of American cotton by American mills; the rise of Japan; cotton-growing in foreign countries; foreign competition; internal competition and depression; the use of artificial silk; the need for improved machinery and mill organization. The lecturer concludes by saying that to overcome the present difficulties which beset the cotton industry owing to the fall in prices, it will be necessary to (1) reduce cost of production; (2) increase quality at same cost; (3) reduce retailing and distributing costs; (4) effect improvements in machinery and methods.

305. The Amani Institute. (Abstr. from *Trop. Agriculture*, vol. iii., **12**, 1926, p. 242.) Mr. William Nowell, who was recently appointed Director of the Department of Science and Agriculture, British Guiana, has been selected to fill the post of Director of the Amani Institute in Tanganyika. Amani is the research station established by the German Government before the war, and it is now proposed to revive it from its semi-abandoned condition and make it serve again for research and investigation, particularly in connection with the agriculture of the British Colonies and Dependencies in Eastern Africa, and to develop its scope to the status of an Imperial institution.

306. The Imperial College of Tropical Agriculture, Trinidad. An interesting addition to the Prospectus for 1927-28 is the Principal's Report for 1925-26, from which it appears that the Associateship of the College has been granted to 8 students, 7 of whom are ex-students of the Empire Cotton Growing Corporation. The field from which students are drawn is ever widening; in addition to the West Indies and the United Kingdom, students in residence during the year have come from the Union of South Africa, 4; Brazil, 1; Egypt, 1; and Ecuador, 1. An account is given of the researches carried on; with the opening of the new Cotton Research Station of the Corporation cotton is becoming a subject for teaching only at the College. A list is given of the papers published during the year, and of the journals in which they have appeared.

307. Cotton could Gird the World. (Abstr. from *Text. Rec.*, xliv., **524**, 1926, p. 94.) In an address on "Manchester and the Cotton Industry," broadcast from the Manchester Station, Mr. William Howarth, President of the Textile Institute, remarked that if the amount of cotton cloth exported from this country

last year were converted into a continuous web, it would make a cotton bandage 100 yards in width right round the world. The figure of cotton consumption in this country from all sources is placed at well over 3,000,000 bales a year.

308. Analysis of the Management of a Cotton-Growing Enterprise. By C. H. Schopmeyer and A. P. Williams. (*Fed. Bd. Vocat. Ed., Bull.* **105,** 1926., Abstr. from *Exp. Sta. Rec.*, vol. lv., no. 3, 1926, p. 284.) This bulletin is an analysis of the managorial jobs connected with cotton-growing, and is based upon an extensive study of practical operations in Texas, Louisiana, and Mississippi. It is intended for the use of vocational teachers and supervisors in the selection and organization of training content, and to illustrate the procedure in analyzing managerial-training content of farm jobs.

309. Cotton Mill: Mechanical Supervision. (*Mech. Eng.*, **48,** 1926. Abstr. in *J. of Text. Inst.*, xvii., **11,** 1926, A. 387.) In the discussion on a paper on fundamental measurements in a cotton mill, the need for better organization and supervision in American mills is emphasized.

310. Modern Industrial Tendencies. By Sir Charles Macara. (Abstr. from *J. of Text. Inst.*, xvii., **11,** 1926, p. 209.) A book of collected writings dealing mainly with the question of the control of the cotton trade as a way out of its difficulties.

ADDENDUM TO COTTON IN THE EMPIRE.

311. South Africa: "*Review of the 1925-26 Cotton Season.*" (This report was received from Mr. Pieter Koch, Principal of the Tobacco and Cotton Division, on the eve of going to press.) During the year under review the weather conditions were not favourable for cotton growing until February, but in spite of this fact the crop was 2,756 statistical bales larger than that of the previous year. As a whole, the cotton was of a much better colour than that of the 1924–25 season, the reports from Liverpool firms being most encouraging. The grading was based on "Universal Standard" and "Liverpool Staple." The losses from boll-shedding and insects were not nearly so serious as during the previous season.

Referring to the prospects for the 1926–27 season, Mr. Koch states that approximately 61,600 acres have been planted to cotton. At the end of January cotton in the Northern Transvaal, Swaziland, and the Northern portion of Zululand was in a backward condition owing to lack of good rains; on the other hand, the news from Weenen and the Southern Districts of Zululand indicated that the prospects of the crop were excellent. At the time of writing no complaints had been received regarding excessive damage by insects.

PERSONAL NOTES

It is with much regret that we have to announce the death of Sir Frank Forbes Adam, C.B., which occurred in London on December 22, 1926. Sir Frank Forbes Adam was elected a Vice-President of the Council of the Corporation at its inception in 1921.

We also have to announce with much regret the death of Dr. A. W. Crossley, C.M.G., F.R.S., which occurred at his residence at Alderley Edge, Cheshire, on March 5. Dr. Crossley was the Director of the Shirley Institute of the British Cotton Industry Research Association, and was also a member of the Research and Training Sub-Committee of the Empire Cotton Growing Corporation.

APPOINTMENTS.

Northern Rhodesia.

Mr. T. McEwen has been appointed by the Government of Northern Rhodesia as Senior Agricultural Officer at the Mazabuka Experiment Station.

OFFICERS ON LEAVE.

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes "home" on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would call at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite to the offices of the Crown Agents for the Colonies.

At the date of writing the following officers are on leave in England from cotton-growing countries:

Gold Coast	Mr. N. P. Chamney.
,, ,, ...	Mr. H. A. Dade.
,, ,, ...	Mr. W. H. Patterson.
Nyasaland	Mr. E. W. Davy.
Rhodesia (Northern)	Mr. T. C. Moore.
,, ,, ...	Mr. G. Walton.
Tanganyika Territory	Mr. D. G. Burns.
,, ,, ...	Mr. C. K. Latham.
,, ,, ...	M. J. F. C. O'Brien.
,, ,, ...	Mr. A. H. Ritchie.
,, ,, ...	Mr. A. J. Wakefield.
,, ,, ...	Mr. E. O. Whitehead.
Uganda	Mr. N. S. Haig.
,, ...	Dr. W. S. Martin.
,, ...	Mr. E. A. Ruck.

The following officers of the Corporation's staff abroad are at present on leave, or will shortly arrive, in England:—

Dr. S. C. Harland	Cotton Research Station, Trinidad.
Mr. W. L. Miller	Nyasaland.

PRINTED IN GREAT BRITAIN BY
BILLING AND SONS, LTD., GUILDFORD AND ESHER

THE EMPIRE COTTON GROWING REVIEW

VOL. IV. JULY, 1927. NO. 3

COTTON SPINNING AND THE COTTON GROWER

BY

CYRIL UNDERWOOD, B.A.

(*The British Cotton Industry Research Association.*)

IT has been suggested that in many cases the cotton grower has no definite idea of what happens to his material in the mill, and to what extent the spinner is interested in the quality of the raw cotton; the purpose of this article is, therefore, to attempt to supply an indication to the grower of the treatment which his raw material undergoes in the hands of the spinner, and especially of the difficulties encountered arising out of the inherent defects of cotton as a workable substance.* It is hoped that this will assist the grower to realize more fully than hitherto how the various imperfections of the cotton hair affect the possibilities of producing good yarn, and how the principles governing the different processes are directed to the overcoming of certain of these limitations. No attempt will be made to describe in detail each machine of the cotton mill, as it is scarcely possible for the cotton grower to be interested in the accessory devices found on every piece of textile machinery, which are rendered necessary by purely mechanical difficulties. It is impossible, however, to realize the significance of the different processes without some knowledge of the principles of action of the various machines, a brief outline of which will therefore be given.† For more detailed treatment, reference may be made to W. L. Balls's "Handbook of Spinning Tests."

THE MILL PROCESSES.

The making of a yarn consists essentially in placing the cotton hairs in such a position relative to each other that they form a thin

* *Cf.* also article in this review, vol. i., 1924, p. 109, by A. J. Turner. The mill processes are there described, but, owing to the importance to the grower of a proper understanding, are again described in a different way here.

† *Ibid.*

thread capable of withstanding a certain pull. Before this operation (which is gradual and demands the use of several machines) is begun, however, the raw material must be passed through certain preparatory processes which are necessary for two reasons.

First, when the cotton arrives at the mill it is invariably contaminated to some extent by foreign matter, such as leaf, stalks, and seed, and occasionally even small pieces of iron and wood are found in the bale; these impurities must, of course, be removed as soon as possible. The commercial value of a cotton is considerably affected by the amount and character of impurity present, and the "grade," as determined by experts at the port of arrival, also depends to a very large extent upon this factor.

Secondly, it is not possible with modern high speed machinery to produce a satisfactory yarn immediately from such a variable substance as cotton, even when all contamination is removed; hairs of undesirable character must be eliminated, and only those which pass certain tests, so to speak, allowed to proceed to the final stages.

The first machines through which the cotton passes in the spinning mill are in a great measure devoted to the removal of contamination. The method of packing, however, renders necessary a second function of equal importance—viz., the "opening" or disentangling of the dense cakes of hairs into which the cotton has been compressed by heavy baling. It is obviously impossible to act upon single hairs—and it is to this that spinning ultimately reduces itself—until this opening has been effectively performed. The earlier machines—"bale breakers," "openers," etc.—are heavy and bulky in design, being constructed to deal rather with masses of cotton than with individual hairs. Although their action, by reason of the size and speed of the moving parts, appears violent, it has been shown that no serious damage is done to the hairs.

In the *bale breakers* the hard "cakes" of cotton from the bale are pierced and torn by steel spikes, and the heavier impurities thrown out. The cotton emerges in the form of small tufts which are further disintegrated by the various *openers*, of which there are several different types in use. Generally, however, the cotton, which is sucked through the machine by an air current, is beaten by rapidly whirling blunt steel blades against grids through which most of the foreign matter still remaining is thrown. The cotton passes from the opener in the form of a "lap." This is perhaps best described as a thick "blanket," from three to four feet wide and about an inch in thickness, which, for convenience of handling, is rolled up on a steel rod so that it takes the form of a cylinder about a foot and a half

in diameter. A number of these laps—generally four or six—are fed simultaneously to the *scutcher*, a machine which continues the cleaning and opening processes in a manner similar to that of the previous machines. The simultaneous feeding of a number of laps at the scutcher marks the first application of a most important principle which is utilized continuously throughout the mill—viz., *doubling*. The object is to attain greater regularity, and it is not difficult to see why the superposition of a number of laps should assist this; for, whilst the chance of a coincidence of thick or thin places in all the laps is very small, the probability is, on the contrary, that the irregularities will, to some extent, "cancel out" when the laps are superposed. Besides this regularizing principle there is on the scutcher (and, in modified forms, on the other opening machines) a device which regulates the feed speed in accordance with the amount of cotton passing at any moment, so that as soon as an extraordinarily dense portion of cotton occurs, the feed speed is automatically reduced and *vice versa*. Thus, the laps produced by the scutcher not only contain cleaner and more "open" cotton, but are more regular in thickness than those from the opener.

The next process is "Carding." The cotton, fed in the form of a lap, is caught and carried round to the "card cylinder" by a smaller cylinder covered with coarse saw-teeth and known as the "licker-in." The card cylinder is densely clothed with very fine wire teeth and revolves rapidly, almost—but not quite—in contact with a second set of similar teeth mounted on "flats"—a number of metal strips linked together in an endless chain which moves very slowly in the same direction over about one-third of the surface area of the cylinder. The wire teeth do not project at right angles to the surfaces in which they are embedded, but are bent to the form of a hook, the inclination of the "cylinder" teeth being in the opposite direction to that of the "flat" teeth. The hairs are carded by the combined action of the two oppositely inclined sets of teeth on the slowly moving flats and the rapidly revolving cylinder, and are removed from the latter by the "doffer," a third cylinder moving more slowly but covered with similar teeth. The doffer is stripped by a vibrating comb, and the cotton appears in the form of a "web" —an almost transparent sheet which, after converging and passing between two heavy rollers, takes the familiar rope-like form known as sliver.

Although the importance of the card is fully recognized, its functions are very seldom correctly stated and apparently often misunderstood. It is not easy to describe exactly what does happen

to the cotton hairs during carding, but it can quite definitely be said that the function of the card is NOT, as is so frequently stated, the parallelization of the hairs. This may be realized immediately by examining the card web, in which the arrangement of the hairs is anything but parallel.

One of the results of the passage of the cotton through the card is immediately apparent—viz., the transformation of the lap into sliver. This constitutes the most extensive "draft" or attenuation ever used in any of the mill processes, the ratio of the weight per yard of the lap to that of the sliver being of the order of 100; in technical language, the card produces a draft of about 100. The principal functions of the card are (*a*) drafting, in the "thinning-out" of the lap to the sliver form, and (*b*) cleaning and disentangling the cotton hairs. "Cleaning" includes the removal not only of foreign matter, such as bits of leaf and seed, but also of short hairs, as well as of weak hairs which do not withstand the severity of the carding action. The card cannot be considered, however, a very efficient eliminator of short hairs, for it undoubtedly permits the passage of some short ones and rejects other long ones which would be perfectly acceptable in the ensuing processes.

The removal of short hairs is much more effectively performed by "combing," a process which is introduced in the production of fine yarns, or of coarse yarns in which unusual strength and quality are demanded. The action of the comber consists fundamentally in passing a series of combs through a fringe of cotton held firmly between nippers. The result of this action is that practically all the hairs shorter than a certain predetermined length (in accordance with which the various parts of the machine are set) are discarded, and much greater uniformity of length is attained in the resulting product.

It is necessary, before combing, to prepare the sliver by passing it through *draw frames* (and other machines the purpose of which is to produce laps of convenient size for feeding to the comber), and on this account "drawing" is usually described first. Combing is, however, essentially a cleaning process, and as such belongs to the same category as the card; the draw-frames are, on the other hand, concerned with the *arrangement* of the hairs, and their purpose is to produce a more regular sliver in which the hairs are straightened and parallelized.

A number of slivers, usually six or eight, are together passed between four successive pairs of rollers, about an inch or so in diameter. The bottom rollers are positively driven, whilst the top

ones are weighted to the extent of from 20 to 50 lbs. per roller, and simply rest on their partners, the motion of the latter being transmitted through the intervening cotton. The gearing is so arranged that the surface speed of each pair of rollers increases progressively from the back line—where the slivers enter—to the front; thus, the sliver, as it passes through the machine, is gradually pulled out or "drafted," the amount of draft being usually such that the resulting sliver is of approximately the same thickness as each of the initial slivers. The drawing process is repeated two, three, or four times, according to the type of cotton and the quality of yarn desired.

It is easy to see how parallelization is effected by the "drawing-out" of the sliver; some of the hairs are caught by the speedier front rollers and dragged over and through those other hairs which are momentarily held in the grip of the more slowly moving back rollers, the result being an action which, for want of a better word, may perhaps be described as "self-combing," made possible by the mutual friction of the hairs. The combination of a number of slivers clearly employs that same principle of "doubling" which was outlined in connection with the scutcher, the irregularities being gradually smoothed out to produce a sliver comparatively uniform in thickness at the "finisher," or final drawing.

In the succeeding machines—*speed-frames*—the cotton hairs are subjected to similar treatment to that of the draw-frames, viz., drawing and doubling. The amount of draft is now increased, however, so that a gradual attenuation occurs, the product of the last frame ("roving") being rather like a length of very soft string, weak enough to be pulled asunder by the slightest tension. For convenience of handling, the roving is wound on bobbins, and in order to effect this without breakage a slight amount of twist is inserted. Thus, although the operation of twisting on the speed-frames is important and gave rise to many complicated mechanical problems, it should not be regarded as a *primary* function; indeed, excessive twist in roving is one of the causes of trouble in the spinning-room, and for successful work the amount of twist put in at the speed-frames should be kept at the absolute minimum necessary to prevent breakage as the roving is wound off the bobbins.

Spinning, on the other hand, consists essentially in the insertion of twist, although still further drafting first takes place. There are two distinct methods of spinning in general use, viz., "mule spinning" and "continuous" or "ring spinning." It is impossible to deal here with the mechanical details of either type of spinning machine, and only a brief indication of the methods can be given

(reference may be made to a paper by Oxley, *J. Text. Inst.*, 1922, **13**, 92). In both types of spinning machine the roving is drawn through three pairs of rollers to the required fineness; in the mule, the characteristic feature is the movable carriage bearing the spindles on which the yarn is wound. The twisting or spinning takes place during the outward run (away from the rollers), and is effected by the slippage of the yarn over the rapidly revolving spindle tips; during the inward run of the carriage the spun yarn is wound on to the spindles in the form of a cop, the two operations of twisting and winding thus being consecutive. In contrast to this, the action of the ring spinning-frame is continuous (hence the alternative name for this method), twisting and winding taking place simultaneously. Here the spindles are fixed relative to the rollers. The yarn passes through a small wire clip—the "traveller"—riding loosely upon a steel ring which surrounds the bobbin; when the spindles revolve, the traveller is dragged round the ring at a rate slightly slower than that of the surface of the bobbin. Thus the yarn is wound upon the latter, twist being inserted by the motion of the traveller.

The advantages and disadvantages of the two methods cannot be discussed here, but at present the use of the ring frame is confined to medium and coarse yarns, whilst the mule is used for all types. A spun yarn is, by reason of the mutual adherence of the hairs in their twisted state and to a varying degree their individual strength, capable of withstanding a tensile force of from several ounces to a pound or more, the exact value of which, of course, varies with the fineness of the yarn.

Imperfections in the Product and their Causes.

In cotton spinning there are, broadly speaking, three kinds of difficulties—those arising out of (1) the nature of the raw material; (2) the inadequacy of the machinery; (3) the "human element"—the capacity of the human being for making mistakes; of these we are here concerned only with the first, in so far as the three sources of error can be treated separately. The second is governed by scientific development; the third is a psychological problem; but the solution of the first difficulty lies largely in the hands of the cotton grower. Now there can be no single comprehensive definition of a perfect yarn, since some qualities—*e.g.*, lustre—are required for certain purposes and not for others; but, generally speaking, a good yarn must be strong, clean, and *regular in every respect.* This last characteristic—regularity—is of the utmost importance, for not only

is the strength of a length of yarn determined by that of its weakest portion, but a very large number of common faults in fabrics, such as stripiness, unevenness in dyeing, etc., are found on examination to be due to irregularity in some form or other (*cf.* Oxley, *J. Text. Inst.*, 1922, **13**, T97). An attempt will therefore be made to indicate the difficulties arising from the use of such an irregular raw material as cotton.

In the first place, cotton of different types will not respond in the same way to similar treatment. It would be unreasonable to expect harsh, short-stapled Indian cotton to behave like a long, silky Sea Island when put through the same machine, and hence variations in the structure and number of machines are found corresponding to the type of cotton in use. High-class cottons of the Sea Island or Sakel type do not require such extensive opening and cleaning, for example, as the dirtier Americans or Indians; and perhaps here it should be emphasized that the amount of impurity in a cotton is an extremely important matter, for hopeless trouble will arise in the later processes in the form of clogged or even damaged machines, if the cotton has not been efficiently cleaned. The importance of cleanliness as one of the essentials of a good cotton will be acknowledged when it is realized that not only does a dirty cotton behave less satisfactorily, but excessive waste means financial loss to the spinner and to the grower.

Correct adjustment of the various parts of the opening machines is as important as in the later processes, but the character of the cotton is equally essential for the attainment of good results. Consider, for example, the action of the scutcher. The cotton is subjected to the action of a bladed beater revolving at a high speed within a cage, the bottom portion of which consists of a grid; the spacing and angle of the bars forming this grid are adjustable, and the setting of these bars is a very important factor in determining the amount of waste produced. Wide spacing of the grid will obviously increase the waste, and if the cotton contains much seed, stalk, etc., it will be necessary to open the bars in order to permit the ejection of these impurities; at the same time, however, much valuable fibre may be lost. On the other hand, if the bars are too close the fibre is preserved, but so also are the impurities. Thus, only by the supply of as clean a cotton as possible, well ginned and carefully baled, can the grower help the spinner to avoid the evils of excessive waste on the one hand, or insufficient cleaning on the other.

Except in so far as different types of cotton may demand slightly different opening treatment, the actual properties of the cotton hair

do not assume great importance until the carding process is reached; for the opening machines are concerned more with masses of cotton than with the manipulation of single hairs, whereas in the ensuing processes its length, convolutions, and other characters may be said to determine, within more or less well-defined limits, the destiny of each individual hair.

A brief indication of the action of the card has been given, but a little more detail will be necessary if the full significance of its treatment of the cotton is to be realized.

The lap is fed between a fluted roller (about $2\frac{1}{2}$ inches in diameter) and a curved metal plate known as the "dish-plate," and is caught as it projects over the nose of the dish-plate by the coarse, saw-like teeth of the licker-in. The distance between the latter and the dish-plate is adjustable, and unsuitable setting may result in damaged hairs or loss of good fibre; in a correctly adjusted card the licker-in waste is very similar to scutcher waste, containing very little fibre in proportion to the amount of seed. The hairs pass from the licker-in to the rapidly moving cylinder, the wire of which is set 7 to 10 thousandths of an inch from the coarser teeth of the licker-in, and are then subjected to the combined action of the cylinder and flat teeth. The exact nature of this action is not as yet completely understood, and important work is being done in an effort to solve the problem of carding. A fairly reliable indication of the efficiency of the card and of the value of the cotton can be gained, however, from the amount and character of the waste produced and from the appearance of the web. A good cotton well carded should not give more than 6 or 8 per cent. waste at the card, of which the largest proportion will consist of strippings from the flats, cylinder and doffer; the web should be unclouded and free from "neps," the presence of which causes infinite trouble in all cotton processes. Neps may be caused by bad carding (due to faulty settings or worn teeth) of a satisfactory cotton, or may result from the presence in the cotton of "dead," "immature," or "thin-walled" hairs; these little knots of curled-up hairs are a continual source of trouble and persist, unless removed by the comber, right through to the finished yarn. When woven into a fabric and dyed, a "neppy" yarn appears spotty, the thin-walled immature hairs showing less intense colouring than the normal fibres (Clegg and Harland, *J. Text. Inst.*, 1923, **14,** T125; F. Summers, *ibid.*, 1925, **16,** T323).

Regularity of staple is so essential for the production of a satisfactory yarn that for high quality work the comber is introduced. It is impossible here to describe adequately any of the actions of this

machine, but the fundamental one is purely and simply a matter of combing a fringe of cotton held firmly between a pair of nippers. The mechanical complications are required by the necessity for perfect timing of several intermittent actions, viz., the nipping of the cotton, the passage of the combs through it, the delivery of the combed fringe forward and the "piecing" or connection of it to the portion previously combed. The cotton is fed to the comber in the form of a small lap less than a foot wide, which is produced by the combination of a number of slivers and then doubled six or eight times on a machine known as the "ribbon lap machine." Further doubling and drawing occurs after combing, and the resulting sliver is composed of hairs which are not only more uniform in length, but are arranged more nearly parallel and distributed much more regularly than in the card sliver. The elimination of short hairs by the comber is easily understood; in the fringe presented to the combs those hairs which, on account of their shortness or curled condition, are not gripped will be combed out; the others will, to some extent, be further parallelized. The amount of waste produced depends on several factors, including the average length of tuft presented to the combs and the depth to which the latter penetrate; these settings are adjusted to particular values governed by a consideration of the staple length of the cotton and the quality of yarn required. Thus, it is obvious that at the comber an irregular cotton will again produce excessive waste—a result which has been repeatedly noted in every machine so far treated; it is, moreover, irregularity not only of length but also of wall-thickness, etc.—*i.e.*, the presence of thin-walled and weak hairs—which is detrimental to the satisfactory working of a cotton, resulting as it does in less economical running as a consequence of the high waste losses.

In the foregoing processes, more or less successful efforts have been made to improve the raw cotton by eliminating undesirable hairs; these efforts now cease and the succeeding machines are solely concerned with obtaining the best possible result from the given material.

The method of drafting between rollers is the most efficient means so far conceived of parallelizing the hairs and attenuating the sliver or roving until it is capable of being spun; and yet it still presents one of the biggest problems in the industry. It is commonly agreed that the results of drafting are far from satisfactory, due to a great extent to the enormous variation in length which exists even in the best cotton. Mechanical contrivances can be constructed to respond more or less sensitively to certain variations of material,

but as soon as a variation unforeseen or beyond prescribed limits occurs, the machine is helpless to deal with it; improvements may be, and in fact are being, designed which extend these limits of action, but advance must also be made from the other end in the way of producing a more uniform raw material by a systematic elimination of all avoidable irregularities (F. Summers, *J. Text. Inst.*, 1925, **16**, T328).

In a consideration of the drafting problem an important question arises as to what is understood in the mill by the *length* or *staple* of a cotton. No satisfactory answer can be given, for different mill experts will give varying staples for the same cotton. In reports on spinning tests done for the Empire Cotton Growing Corporation the staple is given as the *most frequent hair length*, and this seems to be a satisfactory definition, which, however, is found to be inapplicable to cottons of very irregular length—*i.e.*, cottons containing an unusually large proportion of very short hairs.

Now it is clear that a straight hair which is caught in the nip of the more rapidly moving front rollers before it has been released from the back rollers will either be broken or will slip from between the back rollers if the latter do not exert sufficient pressure to hold it; and one of these two things will happen to all those hairs whose length is greater than the distance between the lines of contact of two successive pairs of rollers, a distance which is known as the "roller setting, centre to centre." (The assumption has here been made that the hairs are straight; this is not justifiable, of course, but it is used as the only practical working hypothesis.) When the rollers are set too closely, bad drawing will ensue, and the sliver will in technical language "spew," or emerge in jerks and lumps instead of smoothly and evenly. On the other hand, if the settings are too wide for the cotton in use, the hairs will not be sufficiently controlled and will tend to curl round the rollers or "lick." Correct settings on the draw-frames are most important, especially as defects produced in the early stages of drawing are almost impossible to remedy; and when it is realized that a margin of about $\frac{1}{32}$nd of an inch either way is the limit of inaccuracy in roller setting, it will be plain why the drafting of such a variable material as cotton is so far from ideal. The present arrangement is a compromise in which, broadly speaking, extraordinarily long hairs are broken whilst very short ones will simply be carried along with the rest and undergo very little parallelizing action; only the medium-length hairs can hope to be effectively "drawn" with the ordinary scheme of rollers. Modern developments aim at obtaining more control over the short fibres without at the same time jeopardizing the safety of the long

ones. Many ingenious devices of extra rollers, endless bands, etc., are employed to this end in the various "High Draft Systems" by which either the attenuation or draft may be greatly increased so as to render unnecessary one or more of the intermediate drafting processes, or an inferior (*i.e.*, more irregular) cotton may be used to give the same results with the same degree of attenuation. (Andrews and Oxley, *J. Text. Inst.*, 1922, **13**, T256; F. Charnley, *ibid.*, 1924, **15**, T347.)

Although length is a very important characteristic it is by no means the only factor which enters into the drafting problem. There are other qualities which must be taken into consideration, such as, for example, the mutual friction of the hairs—a "surface" quality and perhaps connected with the number of convolutions or "natural twist" (Adderley, *J. Text. Inst.*, 1922, **13**, T249 and Clegg and Harland, *ibid.*, 1924, **15**, T14); the friction between the hairs and the surfaces of the rollers; the elasticity and "wiriness" or rigidity of the cotton (Peirce, *J. Text. Inst.*, 1923, **14**, T1), etc.—all of which must, from the very nature of drafting, play a big part in the success or otherwise of the operation. The surfaces of the rollers, and the weighting applied to the top rollers demand careful consideration in relation to the character of the cotton; for higher class (Egyptian) cottons the "self-weighting" system is generally employed on the speed-frames, the middle and back top rollers being of iron and exerting by reason of their weight sufficient pressure to ensure satisfactory drafting. Where shorter (American or Indian) cottons are used, however, leather-covered top rollers are employed, and pressure is applied by means of weights hung from a saddle resting on the middle and back rollers. This system is known as "dead weighting" or "saddle and bridle weighting"; the *front* top rollers are dead weighted in both systems. Thus the type of roller arrangement, the weighting, the amount of twist and the extent of the draft are all governed in a great measure by the character of the cotton, which comprises, of course, all the qualities mentioned above —viz., length, fineness of fibre, natural twist, etc.

The relation of the single hair to the spun yarn, the extent to which the properties of the individual hairs influence the properties of the yarn—the whole problem, in fact, of yarn structure—are matters upon which much light has yet to be thrown. Until recently it was thought that what occurred when a yarn broke was rather a slippage of the constituent fibres than their actual rupture. A paper by Miss Clegg (*J. Text. Inst.*, 1926, **17**, T591; but see also *Tropical Agriculture*, 1927, **4**, p. 8) has indicated, on the contrary, that in

certain yarns as many as 70 per cent. of the hairs may be broken; at the same time, however, no correlation has been found between hair strength and yarn strength. In any case, the character of the hairs must be of paramount importance in spinning; the "natural twist," for example, is a matter of no small moment and has considerable influence on the amount of twist inserted, as also indeed has length. (See Oxley and Peirce, *J. Text. Inst.*, 1922, **13**, T172. Peirce, *ibid.*, 1923, **14**, T390.) But the investigation of any single character is extremely difficult on account of the impossibility of *isolating* the required property; the length, diameter, wall-thickness, etc., of a cotton hair seem to be inextricably interdependent, and as yet it has been impossible to correlate the spinning value with any one of these quantities. It is found, for example, that long cottons are on the whole finer than short ones, and thus the superior behaviour of a long cotton may be due either to its length, or to its fineness, or to a combination of both qualities. Generally speaking, however, the characteristic which largely determines the value of a cotton is length, for this governs in a great measure the fineness to which a cotton can be spun. (The fineness of a yarn is expressed by its "count"—the length, in terms of a unit of 840 yards known as a "hank," required to weigh 1 lb.). The possible count of the resulting yarn is not the only thing to be considered in estimating the utility of a cotton; yarn is required for many different purposes, and the amount and direction of twist inserted as well as the count are determined by the ultimate use to which it is to be put. In the weft of a fabric, for example, fulness and softness are of more importance than strength, and there are cottons which give far more satisfactory results when used for a soft-twisted weft yarn than when spun into more tightly twisted warp or "twist" yarn.

Troubles in spinning due to defective raw material hardly ever occur without some previous indication in the earlier stages; for a cotton which has successfully passed through the card room processes can justifiably be expected to spin normally, whilst unsatisfactory behaviour in the draw-frames or speed-frames is a bad omen for the spinner. Of the yarn faults which can be traced to poor cotton, "nep" has already been mentioned; general unevenness is probably the result of bad drafting, which in turn may be due to irregular cotton, whilst dirt, in the form of little pieces of seed coating, etc., may survive the many cleaning processes and spoil the appearance of the yarn.

The problem of the relation between the properties of the cotton hair and spinning value is one of great complexity, and reference may

be made to an article in the January (1927) number of this Review by F. Summers on "The Work of the Shirley Institute in Relation to Cotton-Growing," where the lines upon which the matter is being attacked are indicated. One branch of this work consists in the carrying out of "Spinning Tests" on samples of cotton.

Spinning Tests.

There is at present no trustworthy means of deciding merely from an examination of a cotton what its value as a commercial product is likely to be, and spinning tests have, therefore, been adopted as the only available method of gaining an idea as to the spinning value of a cotton, from a small experimentally grown sample. It was also hoped that these tests might reveal some correlation between the measurable characters of a cotton and its spinning value, but no definite results have as yet been achieved in this direction.

The samples are first received by the Empire Cotton Growing Corporation and by them despatched to the Liverpool Cotton Association, where they are examined and reported upon by expert brokers. They are then forwarded along with the brokers' report to the British Cotton Industry Research Association, where a committee of spinners decide who shall be asked to undertake the spinning. The spinning of the test samples is almost invariably done at a mill; this is supposed to provide a fairer test, as the conditions are practically identical with those of ordinary practice, but it has serious disadvantages; for example, since every sample cannot be spun at the same mill, the conditions are not identical for all the samples. It should be remembered, too, that the spinning of small samples cannot be done without some dislocation of the mill routine, and the obligation due to those spinners who are continually undertaking the spinning of test samples should not be forgotten.

The bale breakers and openers of the ordinary type are not suitable for dealing with such small samples (about 5 lbs.) as are usually sent for spinning tests, and therefore, unless opening machines of special construction are available, the cotton is "hand-fed" direct to the scutcher. The lap thus formed is fed again at the back of the scutcher four or six fold, an attempt thus being made to approximate to the ordinary practice of feeding four or six laps. The resulting lap is carded in the normal manner, the card, however, having first been run bare and stripped (*i.e.*, the cylinder, flats, and doffer cleared of cotton) to avoid risk of contamination. The result of this is that the waste losses (which are obtained simply by subtracting the weight of the card sliver from the weight of the sample)

are exaggerated, the wire teeth taking up more cotton when the card is clean than when it has been running for some time. Since all the samples (as well as the control) are treated in this way, however, the results are comparable, although it should always be borne in mind that the waste losses given in the spinning test reports are distinctly higher than under normal conditions. If the cotton is combed, the comber loss is given separately. It must be urged, however, that too much weight should not be attached to waste loss figures in spinning tests, and the necessity for providing samples as large as possible cannot be too strongly emphasized, for small samples of 5 or 10 lbs. are not only very difficult to manipulate, but often give quite non-typical waste losses. The cotton passes through the remaining mill processes in the normal manner, running side by side with the mill cotton on the same machines, and is finally spun into at least four cops or bobbins of yarn.

The yarn is tested for strength and counts at the laboratories of the British Cotton Industry Research Association under constant controlled conditions, so that results of tests on different yarns are strictly comparable. The finished report—which contains also the judgment of the Spinning Test Sub-Committee on the appearance, etc., of the raw cotton and the yarn—is finally sent to the Empire Cotton Growing Corporation along with the brokers' report. In the meantime, during the spinning and testing of the yarn, work on the measurable characters of the cotton is in progress in the Botany Department of the British Cotton Industry Research Association, observations being made on the length, strength, and "hair weight per centimetre" of the hairs. Records are kept of all these investigations, of the probable value of the cotton as a marketable product and of its behaviour during the various mill processes, with special note of any abnormalities.

The utility of the spinning tests can best be judged by the grower himself, who alone is in a position to decide whether the information obtained from them is of any real value in the way of giving him guidance. From the point of view of the research worker there does not seem to be any *fundamental* reason why ultimately all those properties of a cotton which constitute its spinning value should not be describable in terms of the various characters of the individual hairs, so that the grower, instead of having, as at present, to wait until his product has been subjected to the judgment of the market (which, incidentally, is not always a true criterion as to the value of a cotton), can investigate on the plantation the properties of the cotton hairs and so deduce the commercial possibilities of that particular strain.

In conclusion, it is feared that the reader may have gained from this article the impression that the whole business of cotton spinning is a very vague affair; this is to a large extent inevitable, for pains have been taken to avoid dogmatic statements on questions which are subject to a variety of individual opinions. The work at the Shirley Institute constitutes an attempt to apply scientific methods in the elucidation of the many problems of the cotton industry, not the least of which is that of the relation of the grower to the spinner. At present, the most that can be done is to insist on the dangers of *irregularity* in cotton; to ask for a perfectly uniform product cultivated under conditions which are almost entirely uncontrollable is, it is realized, demanding the impossible. But, at least, it is hoped that sufficient emphasis has been laid on this point to urge the grower to do all he can in the way of eliminating avoidable irregularities, from whatever source—inefficient cultivation, insect pests, careless picking, faulty ginning—these may arise.

Received May, 1927.

THE ENTOMOLOGICAL PROBLEMS OF QUEENSLAND COTTON GROWING

BY

E. BALLARD,

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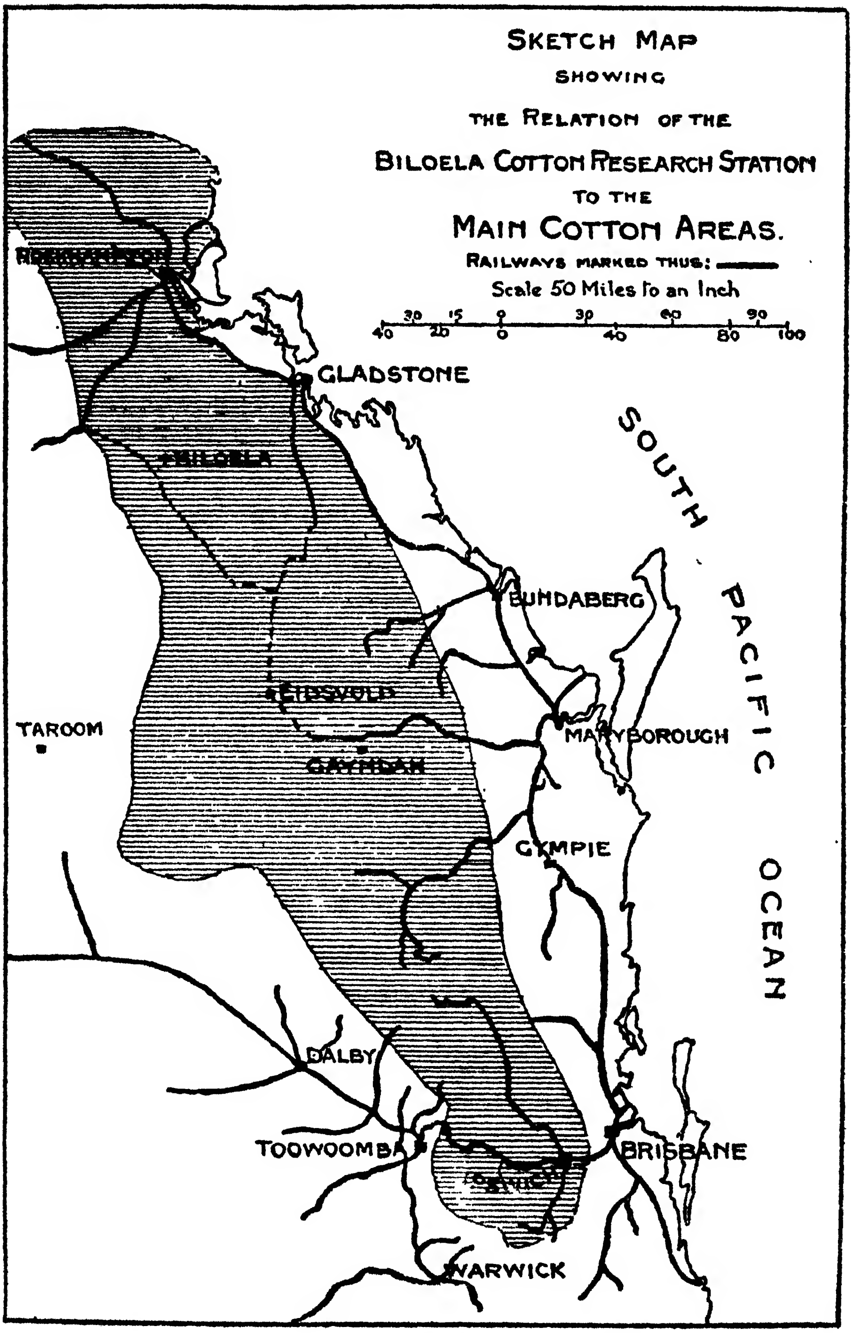
WHEN the Queensland cotton boom began, some five years ago, and when it reached the apex of the boom period in 1923-24, there were two schools of thought on entomological problems. On the one hand were those anxious to advertise Queensland's "wonderful natural resources," who stated that there were no pests, and on the other were the pessimists who declared that Queensland had more pests than any country in the world! As so frequently happens when there are two violently opposed factions, the truth lay somewhere midway between.

The 1923-24 season started with a drought which turned to a flood. Following on excessive rainfall on a late-planted crop (and one often planted with more optimism than experience), one or two species of insects were able to do damage of a spectacular nature. This had a good effect to the extent that entomology was brought into the foreground, so that on the writer's arrival in Queensland, a thoroughly sympathetic atmosphere for work had been created, an atmosphere, it might be added, which from previous experience had been found to be lacking in other lands, where the entomologist is often looked upon as either a nuisance or a joke. What small measure of success has attended the writer's efforts to aid the farmer in Queensland has been very greatly helped by this sympathetic co-operation on the part of the Cotton Section of the Department of Agriculture and Stock of Queensland in particular, and by the Commonwealth Government and the Queensland Government in general, and he would like to take this opportunity of acknowledging it.

Before proceeding further, some short account of the type of country in which cotton-growing is carried on may be given for the benefit of those (if any there be) who have not read Mr. G. Evans's account of "Cotton-Growing in Queensland" in the EMPIRE COTTON GROWING REVIEW (II., p. 169, and III., p. 87).


SKETCH MAP
SHOWING
THE RELATION OF THE
BILOELA COTTON RESEARCH STATION
TO THE
MAIN COTTON AREAS.
RAILWAYS MARKED THUS:
Scale 50 Miles to an Inch
30 15 0 30 60 90
40 20 0 40 80 100
GLADSTONE
SOUTH PACIFIC OCEAN
BUNDABERG
MARYBOROUGH
TAROOM
GYMPIE
DALBY
TOOWOOMBA
BRISBANE
WARWICK

Cotton-growing in Queensland, very largely on account of the high cost of labour, is a matter of small acreages, combined with other forms of farming and dairying. There is no chance of getting rich quickly by growing cotton on the plantation system. The greater part of the Cotton Belt lies behind the coastal ranges at elevations up to 1,000 ft. above sea level, and is roughly 500 miles long by 200 wide. Very little cotton is now grown on the seaward side of the ranges. Seasons are most erratic, and the rainfall fickle. By practising a winter fallow and conserving all the rain that falls during that period, early planting (August, September, or the beginning of October) can take place. If the summer rains are awaited, they may either fail, or the late-planted crop begins to mature when the pest population is at its height; in any case the result is more or less disastrous.

When one speaks of the Cotton Belt, it must not be imagined that close settlement or continuous cultivation exists. The cotton areas comprise a series of groups of farms often widely separated from one another, and with many miles of open forest land or scrub (rain forest) between one group and the next. There is an abundant flora of Malvaceæ and their allies to make a jumping-off place for insects likely to attack cotton.

When the writer first started work in Queensland in 1924, except for the identification of some of the chief cotton pests, very little was known about their habits or incidence, as the industry was too new and staffs too small for detailed work to be done. After some time spent in a survey of the widely scattered cotton-growing areas, the following facts emerged.

Firstly, that the most obvious pest was the cosmopolitan Corn Ear Worm (*Heliothis obsoleta*), only too well known to the farmers, and secondly, that two other insects were of equal importance, but their work, being less obtrusive, had not brought them into the limelight, and very few farmers realized the damage which they were doing. These two were the picturesque "Harlequin Bug" (*Tectacoris lineola*) and the "Stainer" (*Dysdercus sidæ*). There were other pests, notably the Pink Boll Worm and the Yellow Peach Moth (*Conogethes punctiferalis*), and at first it seemed as though the latter would assume first-class rank as a pest, but this opinion the writer saw reason to change later.

One handicap was the complete absence of properly equipped experimental stations, and for the first eighteen months or two years, until the Biloela Cotton Experimental Station began to emerge from the first pioneering stage, work was almost entirely confined to

field observation. This was by no means a bad thing in itself, for work in the field is of greater importance than any other. It meant that one was able to get a fairly complete survey of the different pests and their times of activity, instead of being tempted to start work at once on the pest which was most obvious in a particular district, but might not prove universal. With one or two notable exceptions the pests of one part of the " Cotton Belt " are the pests of another, the exceptions being the Pink Boll Worm and a Jassid, the former being a pest only north of the twenty-sixth parallel and the latter confined to a crop growing in certain soils, particularly red scrub soil of volcanic origin, which is deficient in phosphates and potash.

The problem of the Corn Ear Worm (*Heliothis obsoleta*) was solved by a study of its reactions to temperature. This insect was generally spoken of as though it were primarily a boll worm. In Queensland the real damage is done to the plant while it is setting squares, and although bolls are attacked it seems to be the squares which are the primary attraction. During the late winter or early spring Heliothis only increases slowly, its life-history period becoming shorter as the temperature rises with the onset of summer, and it reaches its maximum population in late December, January, and February. During the latter month its numerous enemies have begun to make themselves felt, night temperatures are beginning to fall, and April sees the end of the attack.

If cotton is planted in September or the first week of October it has set a sufficient number of squares to enable it to keep well ahead of the corn ear worm and to set a crop in spite of even 50 or 60 per cent. of the total number of squares being removed. But if the beginning of squaring coincides with the maximum population of Heliothis, the squares are removed as fast as they are formed, and there is nothing to " hold the plant down " when the summer rains fall, and an excessive vegetative growth is the result. Proof has been afforded again and again that early planting alone will save a crop from corn ear worm without recourse to any trap crops or insecticides. An exception to the rule arises in seasons like the present one (1926-27). Some farmers received a light sowing rain in September and planted. A drought followed, and the plants stood still, beginning to square and flower only after the breaking of the drought in the middle of December. These crops are functioning as late-planted crops, with the inevitable result of corn ear worm damage. Crops sown after the breaking of the drought are almost everywhere suffering in the same way.

At the Cotton Research Station at Biloela, the choice by the pest of the December planted cotton rather than the early planted cotton, which had not been so badly checked as to stop squaring, was very marked, and at the time of writing (March, 1927), while egg-laying is heavy on the December cotton, damage to the early planted crop is only 0·7 per cent. as compared with 6 per cent. on the December crops. Emphasis is laid on this point of early planting, as planting with the summer rains is still extensively advocated in certain quarters. Realizing that occasions must arise when early planting will not be possible, other sources of control were sought. At Biloela in the 1925-26 season complete success was attained by the use of maize as a trap crop. In the present season experiments were to be conducted with a view to using calcium arsenate dust, and for this purpose some plots of November planted cotton were arranged for. This scheme was upset by the drought, and experiments had to be conducted on the late December planted cotton, so that we do not yet know how useful this insecticide will be.

The wandering habits of the caterpillars and the fact that the first or second instar feeds in the terminal buds gave some hopes that success might attend our efforts. Dust was chosen in preference to a spray, owing to the almost universal shortage of water. It is probable that dusting would appeal to the farmer more than the use of a trap crop. The disadvantages lie in the high cost of insecticides and dusting machines in Australia, as compared with the United States, but if the use of calcium arsenate proves profitable this disadvantage may be overcome by co-operative methods. The machine in use at Biloela is a three-row horse-drawn duster imported from the U.S.A.

Maize is nearly always grown by farmers, and generally in two sowings, August to September, and December, so that even a routine maize crop will be of use in attracting corn ear worm from the cotton, since it exerts its attraction at a very early stage. Given, therefore, a fairly good season and not a drought or a flood, advantage taken of winter fallow, and early planting, the corn ear worm so dreaded by the farmers should cease to be a menace.

After the farmer has escaped the maize grub he is not yet assured of a crop which will bring him in a profit, for he still has to face the problem of those insects which pierce the cotton bolls and seeds and permit the entrance of fungous diseases, with stained cotton as the consequence.

These pests in Queensland are two in number, and are known

as the Harlequin Bug of Cotton,* and the Stainer.† The Harlequin Bug is a large shield-bug with brilliant orange, green, and blue markings. The Stainer is a species of Dysdercus, the genus responsible for introducing boll rots in cotton all over the world.

The high temperatures and high humidities experienced on the coast contribute to form the type of meteorological conditions in which both Dysdercus and Tectacoris thrive best. Extremes of temperature (approximately over 100° and under 60° F.), if long continued, result in either death or the cessation of activity. Dryness also has an adverse effect. Extremes of temperature on the coast are rare. Inland behind the ranges where frosts are early and often severe, and where very high temperatures accompanied by low humidity often occur, conditions are apparently engendered which are inimical to the stainers. This must not be taken to mean that they are absent from these places, but only that life is made more difficult for them.

During the drought in 1925-26 season stainers were so scarce until the end of the season (when there was very little cotton) that they were almost a curiosity, and what cotton there was harvested was of high grade.

1923-24 showed drought followed by excessive rains. The writer did not see the beginning of this season, but in April, 1924, on first visiting the cotton areas, he was struck by the comparative scarcity of Dysdercus, although Tectacoris was abundant.

1924-25 was a fairly good season for cotton-growing. There was a heat wave in February, but although Dysdercus was checked by this to a considerable extent it soon recovered, and during this season it was working in the fields from January onwards.

1925-26 opened favourably but soon turned to drought, and only early pickings were taken. Dysdercus arrived late, and, generally speaking, there was little cotton for it to damage.

1926-27 started in drought and broke in floods. February was comparatively dry, but the other months excessively wet. At the time of writing (March) there is every prospect of another wet month. This present season appears to be repeating that of 1923-24, but in a more severe degree. The first Dysdercus migrants were not reported until the end of February, and then only in fields in the vicinity of scrub. At Biloela Experimental Station at the moment of writing Dysdercus is on the Bottle trees (*Sterculia rupestris*) in considerable numbers, but none have yet come to the cotton. The object of giving these details of weather conditions is to show that

* *Tectacoris lineola*, F. † *Dysdercus sidæ*, Montr.

they undoubtedly play some part in deciding whether stainers are going to be in pest conditions in any particular season or not.

When the stock forms of Dysdercus control seemed not to promise to give results under Queensland conditions, investigations into the effects of food and climate on the insect were instituted, in the hope that some light might be thrown on the factors producing abundance and migration. Before any definite theory can be formulated on which a system of forecasting can be founded, continuous observations will be required, and the botany of the host plants, about which there is no information, will have to be studied.

This much at least is known: That pods and seeds of Sterculia species (bottle trees and Kurrajong trees) have a food value equal to cotton bolls and seeds, and that Sida and Malvastrum spp., on which Dysdercus is often found during the winter, only enable it to produce small broods. The adults live long in the winter and a much shorter time in the summer, and are intolerant of high temperatures, 100° F. being somewhere near the critical point. They are migrants, often over a considerable distance, and do not come into the cotton before the first bolls open. In the writer's opinion, the opening of the bolls has little or nothing to do with the act of migration, but once the adults are in the cotton field, an open or opening boll is chosen before anything else. It is not known positively how long migration lasts. Insects bred in the laboratory periodically showed a desire for flight, and were quick to escape from their breeding jars; at other times no such disposition was shown. It is possible that the giving out of the natural food-supply might cause migration, but probably temperature and humidity combinations exert a greater effect, as, in the case of those that wished to fly from the breeding jars, ample food and moisture were present. Put briefly, it seems to amount to this, that Stainers can be expected in the cotton shortly after the first bolls ripen in years favourable to cotton;* and that the proximity of bottle trees will increase the likelihood of attack. In a drought year there will be very few stainers.

So far all attempts at a control method for Dysdercus have failed. Traps of another kind are being tried this season, and one cannot say what the results will be. While believing firmly in the White Australia ideal, there are moments when one longs for gangs of negro or Indian children (preferably the former), to turn into the

* One hesitates to use the expression "normal year," as it is difficult to tell what constitutes normal in Queensland; in the opinion of many a normal year is a drought.

cotton fields for the purpose of catching Dysdercus or Tectacoris by hand.

Absolutely no evidence has come to notice which would suggest that any unbalanced condition of the plant had anything to do with Dysdercus increase. Dysdercus was most plentiful in the season when crops were in their healthiest condition, and scarcest when plants were suffering from drought and flood.

There is no doubt that when present stainers cause a great deal of loss, especially to the top crop, and in any season, good or bad, if a top crop is set at all, it will be damaged by stainers up to 80 per cent. of it. Some *economical* and *simple* form of control is urgently required, for although an early planted crop will suffer less from stainers than a late planted one, early planting does not in itself form a control as in the case of Heliothis.

Tectacoris is very easily hand-picked, as eggs, nymphs, and adults are all conspicuous and easily collected.

These are the chief and universal cotton pests in Queensland, but as the pink boll worm has wrought great havoc locally, something must be said about it. When the pink boll worm alarm was first sounded, its presence in the country was difficult to account for. Subsequent investigations showed it to be firmly established on the coast, living in *Hibiscus tiliaceus*. What appears to have happened is this. Cotton grown in the vicinity of *H. tiliaceus* (between Rockhampton and the coast) became infected; seed from this infected cotton was distributed from Rockhampton Ginnery, and by the 1923-24 season, when the pink boll worm was first reported, most of the cotton area north of Maryborough was infected in varying degrees. It was at its worst around Rockhampton and south from there along the coast, and was least serious inland on the Burnett and in similar areas. Arrangements were made for disinfection of all seed used for sowing, and an attempt was made to introduce legislation to enforce the uprooting of cotton at the end of the season so as to ensure that no standover cotton would be grown. This attempt at legislation in the interests of the farmers fell through, it being found impossible to enforce it, and as many of the ratoon and standover enthusiasts inhabited the coastal areas, the inevitable result followed. One large and promising cotton-growing locality has by now shrunk from 2,000 to 30 acres!

Fortunately it has been possible so far to confine pink boll worm to the originally reported localities, and up to date the southern part of the State is free. There is a light infection in the Callide Valley (a new settlement), which was traced to a field of stand-

over cotton of some 100 acres planted during the boom and abandoned.

Some doubt exists as to whether the Queensland Pink Boll Worm is *Platyedra gossypiella** or not. The evidence for its being a new species is powerful but not conclusive, but whatever decision is come to about it, it functions in a manner identical with *P. gossypiella*, and appears to respond to the usual forms of control.

For the moment the situation as regards the pink boll worm appears to be in hand, but presumably it is simply a matter of time before it spreads throughout the State, as the different cotton-growing centres become linked up. A definite "close season" for cotton would be of immense advantage, but as such a period could only be maintained by legislation, it is scarcely a practical proposition.

The one cotton pest peculiar to Australia as a cotton pest is the so-called Yellow Peach Moth (*Conogethes punctiferalis*). This moth, or rather its caterpillar, is only a pest of late planted cotton, when the upper middle and top crop is attacked. Its appearance seems to depend on the ripening of the summer maize crop. Time has not permitted intensive study.

There are two terminal borers which later attack squares and bolls, *Earias hugelii* and *Crocidosema plebiana*. Although a certain amount of damage is done by those two every season, on the aggregate it is negligible.

Far worse havoc is wrought by cutworms attacking seedling cotton. These, if seen in time, can be controlled by the usual Paris green and bran bait. But clean fallows and headlands would probably be of great assistance, since we have found that eggs are laid as a general rule only in certain situations and under certain conditions, and these are provided by two common weeds of cultivation. It was found also that all attacks of cutworms were invasions, and there was no evidence to show that the moths ever laid their eggs directly amongst the cotton unless their favourite weed was present. Another example of good farming being half the battle where insect pests are concerned.

There is one other insect, a Coreid Bug (*Aulacosternum nigrorubrum* Dall.), which is called the "False Stainer" from its superficial resemblance to Dysdercus. In previous years the insect, while causing some square shedding early in the season, did not appear to be much of a menace. This season it has persisted far after its usual time, and at the time of writing is responsible for 70 per cent.

* "The Pink Boll Worm of Queensland," by F. G. Holdaway, *Bull. Ent. Res.*, vol. xvii., part i.

of the square shedding now in progress at Biloela. In future seasons it might be necessary to keep a watch on it, as it might yet become a serious pest.

There are several small bugs (Capsidæ) which cause square dropping and do minor damage to the plants, but nothing is known of them in detail; and occasional epidemics of leaf-eating caterpillars or beetles might occur, but the insects described above are the ever-present danger, and if only an efficient trap could be devised for Dysdercus the farmer would have little to worry about provided he took precautions such as any fruit-grower has to take.

The question resolves itself into a matter of education of the farmer, and a realization on his part that entomology is as much his own concern as that of the entomologist, and that he must help himself and not expect Government to do everything for him.

Queensland is not the only country in which difficulty is experienced in conveying to the farmers the information one has accumulated, and farm-to-farm visits seem the only solution. For two seasons all newspapers contained information about cutworm baits and how to use them, and not a single case came to our notice of anybody having used the bait when cutworms appeared except when shown by one of the field staff!

In three and a half years it was impossible to do more than lay what it is hoped may form the foundation of more elaborate work on the cotton pest problem of Australia. While the work has naturally been concentrated in Queensland, because no other State is growing cotton on any but a negligible scale, it is hoped that some small help has also been given to Australia as a whole which may assist in the solution of her interesting problems of settlement and development.

Received April, 1927.

CHEMICAL ASPECTS OF SOIL CULTIVATION

BY

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Many agriculturists, and even some of the technical workers in the newer cotton-growing areas, appear to regard the laboratory study of soils as devoted primarily to the analytical estimation of the amount of plant food in soils and fertilizers. Although such determinations formed a large part of the earlier agricultural chemistry, the modern soil laboratory is concerned with more fundamental questions. The recent developments in one branch of soil science—viz., the phenomena grouped under the terms " absorption " or " basic exchange "—will be discussed in this article. It will be seen that this work leads to a clearer picture of the constitution of the soil, and bears directly on such practical questions as the maintenance of soil tilth, the nature of soil acidity, the formation and treatment of alkali soils. Much of this work has been described in foreign journals which are not generally accessible. The writer will be glad to supply more detailed information by letter to those engaged in cotton-growing investigations, and to try out on interesting cotton soils some of the newer methods of studying those problems.

Soil Colloids.

The early soil workers regarded the soil as an accumulation of mineral fragments produced by the weathering of the underlying rocks and modified by the introduction of organic matter from the decomposition of plant and animal remains. Many of the rules of good cultivation could be derived from a consideration of the way in which water films would move over such a mineral framework under the influence of surface tension. Simple explanations were afforded for the differences in water movements in sands, loams, and clays, the effects of cultivation and drainage, and, in arid regions, for the accumulation of soluble salts, the " rise of alkali " after irrigation, the importance of mulching, shading, and subsoil-packing. But the explanations were incomplete, and in some cases led to unfortunate practical consequences. For example, it would appear

easy to wash out soluble salts from such an aggregate of mineral particles by a liberal use of water with drainage, but it was sometimes found that during this treatment the soil became almost impermeable to water and difficult or impossible to cultivate; although the salt content was reduced below the toxic limit, some other and more serious form of infertility had developed.

Whilst recognizing the mechanical effects of the mineral fragments and bulky organic matter, particular attention is now given to the special properties of the finest soil particles and the surface coatings of the larger ones. These not only differ in chemical composition from the rest of the soil material, but have important physical properties and a high chemical reactivity in virtue of their large surface areas. By the use of the supercentrifuge it has been possible to separate from soils a colloidal or ultra-clay with the characteristic properties of a colloidal solution. This colloidal clay is readily flocculated or precipitated out as a bulky mass by the introduction of traces of salts or lime; the individual particles cohere together to form large crumbs which settle out from suspension. Dilute solutions of sodium hydroxide and ammonia render the colloidal clay more stable, and facilitate its extraction from the original soil; these are said to deflocculate the clay. There is close analogy between the effects of these salts and alkalis on the colloidal clay suspensions and on the soil mass itself, either in the laboratory or the field. The colloidal clay dries down to a hard glue-like mass, so that it is clearly one of the factors involved in the cohesion and plasticity of the soil. Chemically it consists of a group of acid salts of rather indefinite alumino-silicic acids produced by the weathering of the soil minerals. Intimately associated with the colloidal clay are humic acid compounds derived from organic remains. Although colloidal clay and humus may be separated by drastic treatment in the laboratory, it is difficult to assess their relative importance in the soil; for most purposes it is sufficient to consider the colloidal clay-humus complex as a whole.

Absorption and Basic Exchange.

It has long been known that soils can retain certain of the important fertilizer elements under the leaching action of rain water. No appreciable amount of phosphate, potash, or ammonia appears in the drainage water from fields. The retention of phosphates is easily explained by the formation of insoluble calcium salts, but there is no such simple explanation to account for the absorption

of ammonium and potassium salts. The salient facts in this characteristic soil absorption were discovered some seventy years ago by Way, the chemist to the Royal Agricultural Society. On allowing a solution of salt such as potassium chloride to percolate through a column of soil, Way found that the early portions of the percolate consisted not of potassium chloride but of calcium chloride, the potassium having been retained by the soil and replaced by calcium. Absorption of bases by soil takes place through an exchange of bases. Way also prepared synthetic double silicates of aluminium giving similar basic exchanges, and concluded that such materials were the active agents in the absorption by the clay of soils. In recent times synthetic sodium alumino-silicates have found important industrial and domestic applications in the well-known "permutite" process of water softening. "Permutite" exchanges its sodium for the calcium of hard waters passed through it. It remains active until all its sodium has been replaced by calcium, but its water-softening power may be regenerated by passing through it a strong solution of sodium chloride; the direction of the change is reversed and the calcium replaced by sodium. · The relatively weak affinity of "permutite" for sodium is compensated for by the high concentration of the sodium chloride solution.

Relatively little further progress was made in the study of soil absorption and basic exchange in the half-century following Way's discovery. Many chemists studied the interactions between definite amounts of soil and salt solution, and obtained very complicated relationships. A great advance was made when the Russian chemist Gedroiz and the Dutch chemist Hissink showed that, by repeated extractions or continued percolation with fairly concentrated salt solutions or dilute acids, the soil yields a perfectly definite amount of exchangeable bases. The amount and composition of these bases are independent of the particular salt or acid used, and show interesting correlations with the behaviour of the soil in the field. Basic exchange takes place so rapidly that it is clearly limited to a very active group of chemical compounds located in the actual surfaces of the soil particles. It is probably a simple chemical reaction between the added soluble salt and the insoluble salts of the alumino-silicic and humic acids in the colloidal clay-humus complex. But as the chemistry of these changes is not yet fully worked out it will be sufficient to refer to them as taking part in the "absorption complex" of the soil. Recent studies on the exchangeable bases in widely differing types of soil have led to a clearer picture of the chemical composition of the soil. The calcium compounds, for

example, may now be divided into the following groups: (1) Soluble salts, present in appreciable amounts only in special saline or "alkali" soils; (2) calcium carbonate, essentially a reserve material; (3) the exchangeable form, as salts of complex clay and humic acids; (4) compounds decomposed only by strong acids; and (5) inert compounds resisting even acid treatment. The most important form is that in the exchangeable state.

Exchangeable Bases.

The actual amounts and composition of the exchangeable bases may be illustrated by the following data for soils from the Broadbalk Wheatfield at Rothamsted.

Exchangeable Bases in Soil from Broadbalk, Rothamsted
(Expressed as Oxides in Per Cent. of Air-Dry Soil).

	CaO *Per Cent.*	MgO *Per Cent.*	K_2O *Per Cent.*
Farmyard manure plot	0·172	0·032	0·064
Unmanured plot	0·380	0·015	0·020

These figures show that the continued manuring has increased all the exchangeable bases, the relative increase being the greatest for potassium. The total amount of exchangeable bases in different soils is roughly proportional to the amount of clay and organic matter, but for many purposes the relative amounts of the bases are more interesting than the absolute amounts. The following table shows that in neutral or slightly alkaline soils, from widely separated areas, calcium is the predominating base, whilst sodium and potassium form only small fractions of the total.

Relative Amounts of Exchangeable Bases
(Expressed in Equivalents as Per Cent. of Total).

	Ca	Mg	K	Na
Rothamsted (farmyard manure plot) ..	85	8	7	—
Dutch soils	79	13	2	6
Californian soils	63	25	4	8

Other types of soil show widely different results. Acid soils are unsaturated with respect to exchangeable bases; they absorb more base than they give up to the salt solution. The difference is made up by acid hydrogen,* and the salt extracts are strongly acid. In

* The apparent contradiction involved in considering acid hydrogen as an exchangeable base arises from the widespread use of the popular and older term "base" instead of the more exact term "kation". Thus hydrogen ion and calcium ion are the kations of sulphuric acid and calcium sulphate respectively, and may replace each other in the soil absorption complex.

the "alkali soils" of arid regions the calcium is replaced partially or entirely by sodium.

After treatment with a salt solution a soil contains only the one exchangeable base derived from the salt. In this way "pure" calcium, sodium, and hydrogen soils and clays have been prepared and studied. Their physical and chemical properties show most of the essential characteristics of neutral, "alkali," and acid soils respectively. The calcium soil is coagulated and dries to a loose crumbly mass, readily permeable to water. The calcium is very firmly held, the calcium clay compounds being insoluble and giving approximately neutral extracts with water. The sodium soil is deflocculated and easily dispersed in water, forming colloidal solutions which are dark and turbid. It is extremely sticky and tenacious when wet, and dries down with much cracking to form a hard, coherent mass, scarcely or not at all permeable to water. Its extracts are alkaline owing to the sodium hydroxide formed by the hydrolysis of the sodium clay compounds. It has in fact all the undesirable qualities of the worst "black alkali" soils. The acid (or hydrogen) soil like the calcium soil is coagulated and permeable to water, but it gives slightly acid extracts.

The extent of the exchange between a soil and a salt solution depends on the affinity of the soil for each base and on the amount of each of the bases present. The affinity of the soil for bases (or kations) decreases rapidly in the order: hydrogen, calcium, sodium. The low affinity of the soil for sodium explains why it is present in very small amounts in soil exposed to abundant rainfall and drainage, and also why sodium should form the principal base of the ocean. In humid soils containing calcium carbonate the production of carbon dioxide by bacterial action leads to the constant formation of a sufficient concentration of calcium bicarbonate to maintain the exchangeable calcium at a high value. The loss of calcium falls on the calcium carbonate, but when the reserves have been used up there is a steady loss of exchangeable calcium, so that the soil becomes unsaturated or acid. In arid regions the absence of percolation prevents the removal of the sodium salts liberated by weathering so that they may accumulate in amounts sufficient to introduce sodium into the exchange complex.

The exchangeable bases of any soil are the resultant of all the processes that have gone to form that soil. A successful beginning has been made in building up a system of soil classification on this basis.

Soil Tilth and Exchangeable Bases.

Even in humid climates where no appreciable amounts of soluble salts can accumulate there are several cases in which the exchangeable bases affect the working qualities or tilth of the soil.

Soils are notoriously difficult to cultivate after prolonged wet periods or mild winters. Dissolved salts are washed out, and the clay readily becomes deflocculated and dispersed, especially where for any reason there is more than a trace of the sodium clay compound.

Sodium nitrate in heavy doses or after repeated applications has been found to spoil the texture of some heavy soils; the practical man says that it " poaches the land." The effect is clearly seen on Barnfield, at Rothamsted, where the continuous nitrate of soda plots are particularly sticky in winter and difficult to break down to a seed bed in spring. The proportion of exchangeable sodium has been increased with a consequent tendency to deflocculation. In Barnfield there is evidence that some of the deflocculated clay has been washed down to the subsoil.

More extreme instances of the same effect occur in land reclaimed from the sea or liable to flooding by sea water or tidal rivers. Immediately after the flooding the soil is in a good state of tilth and is easily cultivated, but with the removal of the salts by rain and drainage the physical state of the soil steadily deteriorates. It becomes very sticky and almost impermeable when wet. and dries out to a hard cement-like mass. It is quite unsuitable for arable crops, and cultivation only intensifies the damage. The most satisfactory treatment is the establishment in the early stages of a clover or seeds ley which can be left down for several years.

The damage by sea water is explained by the replacement of the exchangeable calcium of the soil by sodium. This may be illustrated by the results obtained at Rothamsted in an investigation of some land flooded by an exceptionally high tide in the Humber.

Exchangeable Bases in Flooded and Unflooded Areas
(*Expressed as Oxides. Per Cent. in Air-Dried Soil*).

	CaO *Per Cent.*	MgO *Per Cent.*	K_2O *Per Cent.*	Na_2O *Per Cent.*
Flooded soil	0·39	0·15	0·08	0·18
Unflooded soil	0·53	0·04	0·05	0·08

So long as the sodium chloride and the calcium chloride produced by the exchange of bases remain in the soil water, the soil is flocculated and in good tilth, but as soon as rain removes the bulk of these

salts, the sodium clay becomes deflocculated, making the soil impermeable to water and air, impossible to cultivate, and unfit for plant growth. If a grass crop can be established before the deterioration has proceeded too far, the root action affords some channels for drainage and aeration, and the carbon dioxide production gradually leads to a calcium bicarbonate concentration sufficient to displace the exchangeable sodium and re-form a calcium clay.

Calcium compounds, especially lime and chalk, have been used for centuries as soil improvers. Although they are generally employed as a remedy or precaution against soil acidity, their physical effects are important. On some heavy lands liming may be almost as effective as draining, and it has often been stated that "liming converted a three-horse into a two-horse land." Reductions of draught in ploughing of up to 15 per cent. have been found at Rothamsted from chalking carried out fourteen years previously on land which already contained some calcium carbonate. Occasionally gypsum has given quite striking results on the working qualities of heavy soils, as, for example, in recent trials in New South Wales.

Soil Acidity and Exchangeable Bases.

Although sour soils generally show an acid reaction to litmus paper and other indicators, their water extracts rarely contain any titratable acidity. Salt extracts of such soils, on the other hand, are strongly acid, and the titration of these extracts has been used with partial success for estimating the lime requirements of acid soils. Until recently chemists were puzzled by the nature of acids which were insoluble in water and yet apparently capable of decomposing salts of strong acids; some chemists went so far as to deny the existence of true acidity in soils. But the application of exact physico-chemical methods has now established the fact that most sour soils are truly acid, and has provided exact physical methods of measuring that acidity. The method of expressing the results is rather complicated but sufficiently important to justify some explanation of it.

Water dissociates to a very slight extent into hydrogen ions (H^+) and hydroxyl ions (OH^-). A neutral solution forms the ideal case where these have equal concentrations. In acid solution the hydrogen ion predominates, and in alkaline solutions the hydroxyl ion. Since the product of the concentrations is constant, it is sufficient to express the results in terms of the hydrogen ion only. The numerical values are so small that they are always given as the

pH value, which expresses the negative power of 10, giving the hydrogen ion concentration. Thus a neutral solution with a hydrogen (or hydroxyl) ion concentration of 10^{-7} grams-equivalents per litre has a pH value of 7·0; acid solutions have lower and alkaline solutions higher pH values than 7·0. A unit decrease in pH value implies a tenfold increase in the actual hydrogen ion concentration.

Close agreements have been found between the fertility and the pH values of acid soils. Normal fertile soils containing calcium carbonate have pH values between 7·5 and 8—*i.e.*, very slightly on the alkaline side. Sensitive crops, such as lucerne, fail when the pH value is less than 6, less sensitive crops, such as barley, generally fail before pH 5, whilst extreme values of 4 or less are found only in certain peat or forest soils, or in abnormally treated soils, such as the Rothamsted Grass Plots, which have received heavy annual dressings of ammonium salts for eighty years. Some crops are not adversely affected by an acid soil reaction. Thus potatoes grow well in acid soils, and are less liable to infection by common scab than in neutral soils. Tea grows well in soil at pH values between 5 and 6, and is actually harmed by liming. The relationship between the reaction and the fertility of the soil is largely indirect. It depends in part on the changes in solubility of soil compounds, and also on the different sensitivities to acidity of the soil micro-organisms. Such micro-organisms as the nodule bacteria of many leguminous crops are especially sensitive to acidity, whilst others, such as the fungi causing "finger and toe" disease in swedes and turnips, are favoured by an acid reaction.

The hydrogen ion concentration expresses only the actual intensity of the acidity, and can give no information as to what the intensity would be if alkali were added; the pH value can give no measure of the quantity of acid present or the amount of lime necessary to remove the acidity. Weak acids, such as those of the soil, change their hydrogen ion concentration but slowly as increasing amounts of alkali are added; they are said to exhibit "buffer action." This arises from the presence of either undissociated or insoluble acids capable of providing further quantities of hydrogen ion as those already in solution are removed by the added alkali. The pH value of a soil is intimately connected with its degree of unsaturation—*i.e.*, the extent to which its exchangeable calcium has been replaced by acid hydrogen. In fact, estimations of the exchangeable calcium afford a useful supplement to pH measurements. There is also evidence that plants suffer from an actual calcium shortage on acid soils owing to the depletion of the exchange-

able calcium. To effect a reduction of the acidity of a soil by liming, the dressing must be sufficient to replace a considerable proportion of the exchangeable hydrogen by exchangeable calcium. It is for this reason that large dressings of lime are necessary on heavy soils or on soils rich in organic matter, whereas comparatively small dressings are effective on sands. Soils contain some acids so weak as to remain insoluble or undissociated even in neutral or alkaline solutions, though there is a progressive neutralization of these acids as the alkalinity is increased.

Alkali Soils and Exchangeable Bases.

The term "alkali soil" is widely used for the saline soils found in regions of low rainfall and high evaporation. A practical distinction is made between "white alkali" and "black alkali" soils, according as they show in irregular spots, such as local depressions, encrustations of more or less white crystalline salts, or dark stains from humus. The salts of "white alkali" soils are chiefly sodium chloride and sulphate, whilst the "black alkali" soils contain in addition alkaline salts, such as sodium carbonate and silicate. "Alkali soils" are generally truly alkaline in the sense that they have high pH values, the black alkali soils being more alkaline than the white alkali soils. Thus some completely sterile soils from the Punjab have pH values of 10. Values of 9·5 are common in the Sudan Gezira, and increases of from 0·1 to 0·2 in pH values have been shown to be correlated with considerable reductions in the yield of cotton. The toxic action of the soluble salts on the growing plant is not usually the direct cause of the infertility, and the alkaline reaction is probably more important in indicating the deep-seated physical and chemical changes that have taken place in the soil than in being directly toxic to plants.

Whatever the mechanism of the adverse effect on the plant, there is no doubt that the ultimate cause is the accumulation of soluble sodium salts. It frequently happens that no trouble is experienced in the early years of a new irrigation scheme, but in the course of time the salts begin to accumulate in the surface soil. The added water descends to lower depths than did the rain alone, and during the drying out of the soil brings up salts from these depths. The reduction of this effect is one of the reasons for using a minimum of irrigation water and for paying careful attention to mulching and shading. Methods of improvement or reclamation by drainage, with or without flooding, have proved so successful in

some cases that there is a widespread view that nothing is needed beyond the washing out of the soluble salts. The error of this view has been shown not only in the laboratory, but by the failure of many costly irrigation projects designed on this basis. Black alkali soils rapidly become less pervious to water as the washing out proceeds, and may even become quite unfit for cultivation and plant growth. This has generally been explained by the deflocculating action of the sodium carbonate, which was believed to be formed by the interaction of sodium chloride or sulphate with calcium carbonate. But the trouble is much more fundamental. Alkali soils almost always contain a large proportion of the sodium clay. Flooding and drainage do not remove the exchangeable sodium, and may even intensify the damage. As soon as the bulk of the soluble salts has been removed the sodium clay becomes dispersed, making the soil impermeable and sticky, and hydrolyzed with the formation of sodium hydroxide and carbonate. Sodium carbonate is not the actual cause of the bad condition of these soils, but a necessary by-product in their formation. A permanent improvement of an alkali soil requires not merely the removal of soluble salts, but the replacement of the exchangeable sodium by calcium.

Where the soil still contains a large proportion of exchangeable calcium, drainage alone is often effective. With more exchangeable sodium present, mere flooding and drainage are not sufficient. Application of farmyard manure and the growth of heavy green crops, such as lucerne or berseem in Egypt, facilitate drainage and maintain a carbon dioxide concentration in the soil which tends to reduce the alkalinity and to bring calcium carbonate into solution if the alkalinity is not already too high. Gypsum, especially in conjunction with flooding, has long been used with success. The calcium sulphate restores the exchangeable calcium, whilst the flooding removes the sodium sulphate formed by the exchange. Much greater dressings are needed than were previously thought necessary when they were intended merely to decompose the soluble sodium carbonate. Acids and acid salts have been used in experimental trials, but they are scarcely likely to prove economic over large areas. More recently promising results have been obtained by the application of sulphur. This is rapidly oxidized by certain soil micro-organisms to sulphuric acid, which reduces the alkalinity and so tends to bring into solution any calcium carbonate present in the soil.

In the previous discussion the reactive clay complex has been treated as a stable and permanent material, with chemical changes

restricted to an exchange of bases. Over long periods of time, such as those in which the major soil-forming processes have been in operation, the clay complex itself undergoes decomposition, especially in the more extreme conditions of acidity. Two such changes are of especial interest in the consideration of the processes of soil formation. In temperate regions the clay material of very acid soils gradually breaks up to give colloidal alumina, iron oxide, and silica. The iron and aluminium oxides are removed from the surface soil, which becomes rich in silica and poor in bases; the oxides removed may accumulate in a distinct layer or "pass" in the subsoil, as in many heath and forest soils. In tropical regions the opposite effect occurs, the silica is lost, and the alumina and iron oxides accumulate throughout the soil mass to form the laterite type of soils.

Received April, 1927.

FOLK-LORE FRAGMENTS—II

BY

J. C. MAY.

A FEW weeks after he had inspected the cotton fields round Swewe's villages, the Native Commissioner was seated on his verandah after lunch, talking to the old man about native customs and beliefs. Swewe was his best friend amongst the native Chiefs of the district, and often came and sat himself down on a mat on the verandah steps to see if the Bwana was disposed to talk. Having come to the end of a discussion regarding the marriage ceremonies of the Wabona, the Commissioner asked how his cotton was doing. "Well, Bwana, fairly soon it will be ripe, and when I have sold it, I shall be able to buy some more cloth to wear.

"The Bwana is always asking me to tell him the stories the women tell their children to keep them quiet and to teach them wisdom; I have thought of one that concerns cotton. Long, long ago, at the beginning of the world, when all men were black, our first ancestors wore skins. Many could not obtain skins that were large enough, and they found out that one could make cloth from the bark of certain trees.* Then God looked at the earth and thought that if men did not have other things to clothe themselves in besides skin and bark cloth, they would kill all the animals and cut down all the trees from which cloth could be made. He therefore gave them cotton yarn already spun, and it had only to be woven to make it into cloth. His messengers came with the yarn and showed the people how to weave, and from time to time they came and brought a further supply of yarn. But our ancestors were foolish people, and grumbled because they had to weave: they would have liked God to have given them cloth all ready to wear. Now one of God's messengers was one evening walking through the first village that was ever built upon the earth, and he heard the men who were sitting round a large fire in the open space in the middle of the village grumbling because the stock of cloth had run low, and they would

* This is very common in tropical countries; trees belonging to various families are used. The log is often retted in water for a time, and the whole bark slipped off. Then, after further retting, if required, the cloth-like network of fibre is removed from the pulp by beating.—ED.

therefore have to start weaving once again next day. The messenger said nothing, but when he reached God's house he spoke first of the message upon which he had been sent, and then mentioned that men were grumbling at having to weave. Then God was angry and said: 'Men have become proud and reluctant to work; go you to the village to-morrow, for I am minded to humble them.' And He instructed the messenger what he should say. So in the morning the messenger went to the village, and on the way he plucked a cotton bush with a number of bolls upon it, some green and some ripe. He found the men weaving, and grumbling because their backs ached through leaning over the looms. So he said to the men: 'Why are you grumbling?' and they answered: 'All things are God's: why then does He give us yarn and not cloth, that we might be saved the labour of weaving?' Then the messenger spoke as he had been instructed: 'It is God's wish that men should work, for if you did not work hoeing your crops and building your houses or weaving your cloth, what then would you do but eat and sleep and hunt game? It is not good for man to do no work.' Then the men asked: 'Why is it good for men to labour?' and the messenger replied: 'Answer my questions first. What is inside an egg?' And they answered: 'We do not know.' Then he replied: 'First there is the yolk and the white, but later a chicken.' Then he held up the cotton bush, and pointing to one of the green bolls he asked: 'What is inside this egg?' They answered in bewilderment: 'We do not know.' The messenger said: 'Now there is soft green pulp, but later there is what you will henceforward need,' and he pointed to the ripe seed cotton hanging from one of the bolls that had burst open. But the men said: 'What is this that you say we shall need? It is a weed; there is much growing round the village.' Then the messenger replied: 'When the fruit is young it contains green pulp, but later it ripens into cotton. You have grumbled, and God will no longer give you yarn, but you must gather your cotton and separate the seeds from the lint, and comb it out and spin it into yarn before you can start to weave. For those who have little to do grumble, but those who labour have no time in which to grumble.' "

"Thank you, Swewe; I have enjoyed your story," said the Commissioner. "Now I suppose we must act up to it and go and do some more work, for I see a policeman coming to report something."

One of the Native Police came up the path and saluted. The Commissioner saw that it was Private Stambuli, whom he had sent

to Mwaigo's village to investigate the disappearance of a bull. The animal had been reported as missing from the camp of an officer of the Public Works Department, who was supervising the building of a bridge some twenty miles away. Stambuli being told to report stated that he had gone to Mwaigo's village, that Mwaigo had told him that he knew who had stolen the bull, and had accompanied him to the village of another headman, Maso, where he had taken in charge the man stated by Mwaigo to be the thief. The Commissioner asked exactly where Maso's village was, as he could not remember having heard of it. Stambuli replied that they had left Mwaigo's at about nine o'clock at night and had arrived at the hut in which Tulwe, the supposed thief, was sleeping, at about midnight. Hearing that all the people concerned in the case were up at the Office, the Commissioner suggested that Swewe should come and sit as Assessor, and all three walked up to the Court.

Taking his seat after returning Mwaigo's greeting, the Commissioner asked who was the man accused of the theft. A young man was led forward by the Sergeant of Police, who stated that his name was Tulwe. Being asked to plead Guilty or Not guilty, he burst into an impassioned speech, from which the Commissioner gathered that not only was he not guilty, but he was a most injured man. Stopping the flow of eloquence by holding up his hand, the Commissioner told the Interpreter to tell Tulwe that he understood that he pleaded Not guilty, and that he would be given full opportunity for stating his case when the evidence against him had been heard. Mwaigo was then cautioned to speak the truth, and instructed to tell his story. "Bwana," said Mwaigo, "you sent me a letter saying that you wished me to collect three head of cattle from amongst my villagers and to take them to the European who is building the bridge over the Mbaka in order that he might buy them as food for the men working on the bridge. This I did and the European paid Rs. 28 for each animal. A few days afterwards the policeman standing over there came to me and told me that one of the animals had either broken out of the kraal or had been stolen. I asked my people about it, and two men told me that they had heard Tulwe say that he was angry because a bull that he had paid to his father-in-law as part of the bride-price for his daughter had been sold to feed the men who were working on the bridge. He had told them that he would go and take back his bull. Tulwe then went by night and dug a hole at the side of the cattle kraal at the camp near the bridge, pulled out three of the poles, and went into the kraal without the watchman seeing him, and called to his bull,

and it followed him out through the breach in the kraal and so back to my village. When he got near the village Tulwe led the bull into a thicket of bamboos and there killed it. So when the policeman arrived I told him that I knew who had stolen the bull, and taking one of my men with us as soon as it was dark, we went up to the thicket of bamboos above the village, and hid at the place where the bull had been killed, as there was still some meat there, although Tulwe had sold most of it. Soon afterwards the moon rose, and after a little time we heard someone creeping stealthily up to the place. We sat quite still, though the policeman asked me in a whisper whether it could be a lion. I told him that it could not, as there were no lions near the village. Presently we saw Tulwe come out into the moonlight in the little open space in which the meat was lying covered in banana leaves, and we jumped up and caught him before he could run away."

The Commissioner sat back in astonishment, but tried not to betray his surprise. He glanced at Swewe, who was looking at Mwaigo with a sphinx-like expression on his face, and then at Private Stambuli, who, being a Kiswahili-speaking native and but lately drafted to the district, had evidently failed to follow most of the story spoken so rapidly in a dialect still new to him.

Ben, the Interpreter, commenced to repeat the evidence, for by native custom a Chief seldom addresses his people himself when adjudicating their differences, but employs a "mouth" or interpreter both to voice his judgment and to repeat to him what has been said. This custom is followed by European administrators even when they are thoroughly conversant with the various dialects spoken in their districts, whilst when some of the dialects are strange they have of necessity to depend upon the Interpreter to translate the evidence. It was the Commissioner's rule that the evidence should be repeated in the dialect in which it had been given, if he himself could speak it. Ben accordingly recapitulated what Mwaigo had said in Kibona, and Mwaigo nodded his head at intervals to show that his story was being correctly told. Meanwhile it was evident from the policeman's face that he still did not follow what was being said.

Mwaigo, on being told to continue, soon finished his story by stating that they had taken Tulwe down to the village, and after he had spent the night under guard they had started for the Boma. "Tulwe is a bad man," concluded Mwaigo; "he has caused much trouble in my village, and now says that Maso is his Chief and not I, though he was born in my country."

Private Stambuli was next told to give his evidence, and after Ben had warned him to speak the truth, he repeated in Kiswahili—the official language of that part of Central Africa—more or less word for word what he had reported to the Commissioner at his house. When he came to the journey by night to Maso's village and Tulwe's arrest, the Commissioner observed Mwaigo's jaw drop in horror, and it was evident that, like most of the Chiefs of the district, he understood Kiswahili. A glance at Swewe's face showed that he had allowed himself a slightly contemptuous smile. The policeman came to the end of his report, and the Commissioner, turning to the Interpreter, said: "Repeat the evidence, not in Kiswahili, but in Kibona, so that all these villagers may understand, for I doubt if many save Mwaigo can speak much Kiswahili."

This time it was the turn of the man whom Mwaigo had pointed out as having accompanied him and Stambuli to the bamboo thicket to look horrified.

"Ask Mwaigo," said the Commissioner softly in Kibona, "who speaks the truth, he or the policeman?"

Mwaigo hesitated for a moment. "The policeman, Bwana."

"Why, then, has he lied?" asked the Commissioner.

"Bwana, a bull was reported as having been stolen. It had been sold by me; the bridge is in my country, and when a bull belonging to the Government is stolen, someone is sent to prison. I did not know who had taken the bull, but Tulwe left my country and went to live in Maso's village, and I was angry with him. Someone had to go to prison, and Tulwe deserves no good from me."

"Whose was the bull before you sold it to the Bwana at the bridge?" asked the Commissioner through the Interpreter.

"My own," replied the headman.

"Why did you think that I would believe your story?" was the Commissioner's next query. "Did you not think that I should question the policeman?"

"The Germans asked but few questions when something belonging to the Government had disappeared," was the naïve reply.

"Ben, ask this headman if he knows where the bull is now," commanded the Commissioner.

Mwaigo answered that it was at his village; it had not been stolen, but when it found itself all alone in the kraal after the other animals had been killed for meat for the bridge builders, it had burst its way out and run back to the village.

"Mwaigo," said the Commissioner, "I shall not punish you as I should an ordinary villager, as you are a village Chief, though

an unimportant one and a liar, but in order that you may learn that it is best to speak the truth, you will come here and sit in the Court every weekday for the next month; after that you can go home. I do not mind where you sleep, and you must either buy your food or have it sent to you from your village. Further, the Bwana at the bridge will require three more cattle for food; ordinarily another village would have supplied them, for I know that you do not like selling your cattle, even for Rs. 28, unless spare bulls can be found. You yourself, from your own cattle, will supply three more for which you will be paid, and you will send back with them the bull that escaped. Now you can go: to-morrow you will sit here at the Court, and all will know that you lied to the Bwana. As for Tulwe, I have noted in my book that he lives at Maso's village and not at yours. Ben, ask Tulwe if he wishes to say anything."

"He says, sir," replied the Interpreter after he had put the question, "that he has nothing to say, but that he thanks the Bwana for allowing him to remain in Maso's village."

"Bwana," said Swewe as the Court-house was emptying, "a man would think that Mwaigo had never heard our saying, 'Mr. Cocksure was left with a skull.'"

The Commissioner nodded and smiled, and said: "Swewe, you have a saying to meet almost every case."

On the way back to the house the Commissioner cast his mind back to the day when the porter who was carrying his lunch basket had told him the meaning of this saying. It had then been evoked by the antics of the youthful assistant to his cook, who was a member of a tribe rather looked down upon by the Wabona, and who was at that moment showing off, and worrying the other porters who wished to rest in the shade.

Most tribes in Central Africa have a number of sayings rather of the nature of proverbs based upon a story, and many of them are extremely apposite. Natives are very hospitable, but certain rules of conduct are laid down regarding strangers, who are not supposed to join in discussions unasked, or to obtrude themselves unduly.

A young man known to his friends as Mr. Cocksure arrived one night at a village at which he was a stranger. He was given food and a mat to sleep on. After he had retired to rest he heard the sound of clapping hands outside, and knew that some of the youths of the village must be playing "catch ball" in the moonlight. He fancied himself very greatly at this game, played by two sides of

equal numbers, in which a ball is cast from one member to another of the same side while the opponents try to intercept it. The recipient throws himself into an attitude calculated to make the catch as difficult as possible whenever he can in order to taunt his opponents, while at the moment when the ball is caught, it matters not by which side, all the players clap their hands as one man. Mr. Cocksure, therefore, crept out of the hut and joined in the game. He caught the ball several times in the most exaggerated attitudes with his back nearly parallel with the ground, and generally attempted to show off. Suddenly he intercepted a very high catch, and as his hands closed on the ball he felt that there was something odd about it. A shiver ran down his spine, and he realized at the same moment that there had been no sound of clapped hands from his fellow-players. He looked round and found himself standing all alone in the moonlight in the centre of the open space in the middle of the village—his comrades had vanished. He glanced down at the thing in his hands, which felt cold as a stone—it was the blanched skull of a child. He was petrified with fear, for to touch a human bone is to bring down upon yourself the worst of ill-luck; he did not know which hut he had been given to sleep in, and there he remained gazing stonily at the skull until the morning, when the villagers emerging from their huts found him standing and staring stupidly—*at his empty hands!*

The Commissioner thought to himself how aptly the saying applied to Mwaigo; he had tried to be clever and to revenge himself on one of his men who had dared to move to another village, and at the same time to get back his bull for which he had been paid. Instead he had been " left with a skull "!

THE IMPROVEMENT OF COTTON IN SOUTHERN NIGERIA

BY

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In recent years much has been written concerning cotton in Southern Nigeria from every aspect save one, that being the isolation of an improved strain of indigenous cotton. It is the purpose of this paper to discuss the necessity for the isolation of such a strain, to outline the methods used, and finally to record the results achieved. At the risk of repetition, and, indeed, of plagiarism, it is necessary at the outset to describe the peculiarities of the cotton industry in Southern Nigeria.

In this country there are large areas, notably in the Oyo and Abeokuta Provinces, where a native cotton industry has existed for some centuries. In the districts more remote from the oil palm belt, cotton cultivation, together with spinning, weaving and dyeing, forms an occupation of no mean importance to the inhabitants; but in the neighbourhood of large towns and on the fringes of the oil palm belt the industry is subservient to the more lucrative occupations of food production and the sale for export of palm oil and kernels. On account of the considerable local consumption of raw cotton, low prices have never seriously menaced cotton growing in Southern Nigeria, and the export figures are significant only as a rough index to the prices offered at buying stations. It appears that the farmer sells his cotton for export if it pays him to do so, and if not, he sells it in the native markets, either as seed cotton, yarn, or cloth. Thus it will be seen that to encourage and stabilize the export trade, the production of a high-grade cotton is necessary, so that in years of low prices the premium will maintain the local price above the level at which sale for export ceases to be attractive. The cultivation of such a cotton is particularly desirable in this country where the cost of transport is high, the only means available to the peasant producer being the head load.

The type of cotton at present cultivated in the Western Provinces is a degenerate *Peruvianum.* The plants are vigorous and of rapid growth, and yield a short, harsh staple with a brown tinge. The

value of the highest grade of lint is approximately that of American Middling, and the ginning percentage is low. For many years attempts were made to interest the native farmers in American cotton (chiefly Allen's Long Staple), which, by happy chance, had proved successful in Northern Nigeria. The project was a dismal failure; the farmers would have none of it despite the premium offered. In 1923 were commenced a series of exhaustive investigations of the factors affecting the cotton plant in Southern Nigeria, with special reference to a comparison between the environmental reactions of Allen and native (*Peruvianum*) cottons. From the many interesting points which emerged, two conclusions may be selected as of outstanding importance for our purpose, firstly, that the Allen plant is definitely the more susceptible to insect attack; and secondly, that the short intense flowering period of Allen cotton constitutes a grave risk, as should insect attack be severe at this time, a poor crop will result. The more leisurely flowering of the indigenous cotton is in the nature of an insurance ([3], [7], [8] and [9]). It appears, however, that the paramount reason for the unpopularity of Allen cotton among the farmers is its unsuitability to mixed cropping. The native farms in Southern Nigeria consist of small, roughly cleared patches. The soil is hoed into small hills about two feet in height, and on these hills may be grown as many as four different crops simultaneously. In June or July it is the usual practice either to plant cotton through the established yam crop—to use it as a catch crop between early maize and yams—or to grow it with late maize. The free-growing native type is able to compete with the other crops, but the small Allen plant is seriously hampered. It seems likely, even in this connection, that the concentration of the bolling period in Allen cotton places it at an additional disadvantage, for the sudden demand on the soil could hardly be satisfied under such conditions of severe competition. Hence the problem has resolved itself into the isolation from types vegetatively suited to mixed cropping of a cotton commanding a comparatively high premium, and, in view of the lack of transport facilities, of as high a ginning percentage as possible.

The Choice of a Parent Stock.

It seemed that the choice of a parent stock was limited to an indigenous cotton which had been evolved under the prevailing native system of agriculture. The *Peruvianum* cottons of the Western Provinces did not appear to offer as promising a source for selection as did the naked seeded types grown in the Niger and Benue valleys,

particularly in the Ishan division of the Benin Province, and in parts of the Kabba and Munshi Provinces. These cottons are generally referred to as *G. vitifolium.* Apart from quality of lint, comparative freedom from fuzz forms the most constant distinguishing feature between them and the *Peruvianum* types. The origin of these cottons, and the reasons for their localized distribution, are matters for speculation. For many years, and perhaps for centuries, they have existed as mixed but surprisingly superior populations. Owing to transport difficulties, very little of this cotton has been exported; it is almost all used locally. The Munshi and Kabba types are, on the whole, much later maturing than that of Ishan, and they possess larger leaves. In January, 1924, the author toured the Ishan district in search of superior types. Here cotton is grown in mixed culture, and white and brown linted plants are scattered indiscriminately about the farms. Usually the seed cotton is segregated after picking, and the brown and white lint is spun independently. Cloth with alternating brown and white stripes is commonly woven. Twenty single-plant selections were made from native farms. The selection was based almost entirely on lint length, but one exceptionally prolific brown-linted individual was included. Seeds of these selections were planted in progeny rows at Ibadan in July, 1924, and the flowers were selfed. The resulting population was sufficiently varied in character to afford ample scope for selection. Only three of the white-linted parents bred true, the percentage of brown-linted individuals among the remainder varying from three to twenty-three. The progeny of the one brown-linted parent contained 16 per cent. of white-linted plants. Unfortunately circumstances did not permit of the investigation of the inheritance of the brown lint character. From a total population of about seven hundred plants, only three completely fuzzed individuals were found. This character has never reappeared in succeeding generations, and it seems probable that the degree of interspecific hybridization in the Ishan district is slight. This cotton-growing area is isolated from others by natural boundaries, a fact which doubtless accounts for the comparative purity of the indigenous race.

Selection Methods.

In general, the method adopted consists of the isolation of long-stapled strains by inbreeding and selection from the progeny of superior plants chosen from native farms. The scheme adopted for the multiplication, testing and ultimate distribution of pure lines has been described in a report by Col. French,[2] but it should be mentioned

that the reference therein to mass selection in strains under multiplication is due to a misapprehension. Possibly mass selection of cotton, if continuous, is both desirable and effective under certain circumstances, but never when practised within a pure line. The method of self-fertilization, which was introduced to Nigeria by Dr. T. G. Mason, is simple and efficient. Early in the morning and late in the afternoon the plot is visited by a gang of small boys under an overseer. Each boy is armed with a number of lengths of fine string. All flowers, the corollas of which are sufficiently developed but not yet open, are tied just below the tip. On the following day the overseer ties a loop of string round the pedicel of each flower which has turned pink, provided that its corolla string is still intact. Thus selfed and unselfed bolls are readily distinguished at the time of picking. Each plant is harvested, and the selfed produce stored in individual plant bags to await laboratory investigation. The number of vegetative branches and the position of the fruiting system on each plant is noted in the field. Leaf and boll indices were determined during the earlier years, but these appear to be without much significance. A record is also kept of the date of the appearance of the first flower on each plant, and of the number of bolls harvested. In the laboratory, the contents of the individual plant bags are examined and determinations are made of lint length, ginning percentage, weight of lint per boll, seed weight and lint index. As from one to two thousand bags are examined annually, it was necessary to evolve a rapid system of lint measurement which could be used by native assistants. The maximum lint length measured, after combing and pulling, was found to be the most satisfactory. The figures thus obtained are of little value intrinsically, but the method offers a rapid means of making a preliminary selection of exceptionally long-linted plants. Ginning percentage is determined on a 4-inch roller gin made by Platt Bros. of Oldham. The ginning and weighing of the whole population is completed in as short a period of time as possible, in order that the considerable variations in atmospheric humidity may not affect the comparative value of the figures. In any case, the ginning percentages for one year cannot accurately be compared with those of another. This also applies, to some extent, to the annual comparison of weight of lint per boll and of lint index. When the preliminary selections have been made, these are examined in greater detail preparatory to a final selection of one plant from each strain. The mean lint length is now determined by single hair measurement and by the Balls' sorter, and calculations of hair weight per centimetre will, in future, be made in addition. While the lint characters are

considered to be of primary importance in selection, the question of earliness and its bearing on yield is not neglected. In Southern Nigeria insect pests and fungous diseases, with the exception of anthracnose,[4] diminish during the latter half of the season, when aridity becomes marked; thus a late maturing cotton might escape much of the infection suffered by an early one. On the other hand, during years in which the rains cease abnormally early, or in which the *harmattan* is exceptionally severe, a late cotton might be at a disadvantage, especially if grown on a light soil. It was therefore decided to attempt to isolate a range from early to late maturing types, pending the accumulation of further data on the subject. Working on the total population made up of the progeny of the original field selections, the author, in collaboration with Dr. Mason, showed that early maturity is highly correlated with the position of the fruiting system on the main axis, and independently, with the percentage of bud-shedding on the lower fruiting branches.[5] Unfortunately the position of the fruiting system, as measured by the number of the nodes on the main axis from which the first fruiting branch springs, proved to be a character of extreme variability, and no great measure of success has attended attempts to fix it. Nevertheless, by using this criterion, a fairly complete range of types has been isolated. It has been found that A and B, the two late strains, proved heavier yielders than any of the early ones during two widely different seasons and in three localities. However, it is not possible definitely to correlate high yield with lateness, though the theoretical considerations mentioned above indicate the probability of the existence of such a relationship under Southern Nigerian conditions, where acute water shortage is exceptional. Final selections then, based as they are on all characters, are necessarily dependent on personal judgment. One from each strain is admitted to the selection plot of the following year, and the remaining seed bulked by strains for multiplication, should the cottons be considered sufficiently pure and promising to warrant this. Ultimately a reservoir of seed of the pure line under distribution will be preserved from contamination by growing a number of plants each year in bee-proof cages.

The Progress of the Selection Work.

It remains, then, to indicate the progress achieved by these methods. This has been summarized in schematic form in Table IV., but it is necessary, in addition, to give a brief account of each year's work. The establishment of progeny rows in 1924 from the seed

obtained from the original field selections has already been mentioned. Seven plants were selected from the resulting population, the remainder being discarded. These seven were named A, B, C, D, E, F, and G, and were derived as follows:

$$\text{Original Selection No. } 2 \begin{cases} A \\ B \end{cases}$$

$$\text{,, \quad ,, \quad No. } 4 \begin{cases} C \\ D \end{cases}$$

$$\text{,, \quad ,, \quad No. } 11\text{—}E$$

$$\text{,, \quad ,, \quad No. } 17 \begin{cases} F \\ G \end{cases}$$

It will be seen that A and B, C and D, F and G are sister plants.

In 1925, progeny rows of these seven selections were arranged to form a yield test in addition to constituting a selection plot. Rows of *Peruvianum* cotton were included as a standard, the seed being obtained from the Ibadan ginnery. Considerable vegetative differences were observed between strains, but sister strains resembled each other fairly closely.

Taking the early stage of the work into consideration, every strain was remarkably homogeneous. Neither the fuzzed nor the brown-linted characters reappeared. Varying degrees of resistance to the disease of leaf curl were noted, strains A and B being practically immune. A separate account of this will be published shortly.[6] The yield test showed that strains C, D, and E were definitely less productive than the *Peruvianum* type, that B was definitely superior, the results in the cases of A, F, and G being inconclusive. On account of the comparative inferiority of the lint, and in the case of C, of the extremely low yield, it was decided to discard all but strains A, B, D, and E. Lint samples of these cottons, together with a sample of *Peruvianum* for comparison, were examined at the research station of the Fine Spinners and Doublers Association at Bollington. A spinning test showed that the waste figures were abnormally high, but apart from this, that strains D and E closely resembled a standard second-grade Ashmouni. Strains A and B, being coarser, were inferior to D and E. The *Peruvianum* sample was immeasurably inferior to the Ishan strains. The high waste figures may partly be accounted for by the smallness of the samples and by hand roller ginning, but the defect seems to be common to West African cottons, all of which are rain-grown, and it may prove a difficult

fault to eradicate. A summary of the spinning test figures is given in Table I.

TABLE I.—SUMMARY OF SPINNING TEST REPORT.

	Total Waste (per Cent.).	Count-Strength Products.			
Counts		30s. mule carded		60s. mule carded	
Twist factors		3·25	3·75	3·25	3·75
Samples:					
Standard (*Peruvianum*)	27·7	1,244	1,540	399	730
Ishan A	25·3	1,671	1,794	800	1,136
Ishan B	21 2	1,806	1,961	1,070	1,354
Ishan D	16·4	2,187	2,274	1,724	1,811
Ishan E	23·1	2,328	2,482	1,820	1,888
Ashmouni Control ..	11·8	2,286	2,420	1,746	1,818

In the 1926-27 season, selection work was continued at Ibadan within strains A, B, D, and E, and new field selections were introduced. The remaining seed of the 1925-26 crop was bulked by strains for multiplication. While it was realized that the strains were not likely to be pure, multiplication at this stage appeared to be justified. All strains were, under the circumstances, remarkably homogeneous and vastly superior to the cotton to be replaced. The seed available for multiplication was limited, and some difficulty was found in obtaining plots sufficiently isolated from other cotton. However, by adopting as wide a spacing as the land permitted, and by sand sowing[1], satisfactory returns were obtained. These are summarized in the following table:

TABLE II.—PROPAGATION RATES: MULTIPLICATION PLOTS 1926 27.

Strain.	Seed Sown.	Seed Harvested.	Seed Sown.	Seed Harvested.	Remarks and Spacing.
A	4 lbs. 6 ozs.	2,200 lbs.	1	500	Good land, 5 by 4 feet.
B	8 lbs. 2 ozs.	1,150 ,,	1	140	Poor land, late planted, 6 by 4 feet and 6 by 2 feet.
D	5 lbs.	800 ,,	1	160	5 by 4 feet.
E	4 lbs.	580 ,,	1	145	4 by 2 feet and 5 by 2 feet.

Lint samples of the early crop were sent to England, and through the courtesy of the British Cotton Growing Association, they were valued independently by several brokers. The various reports, quotations from which follow, were substantially similar.

"*These cottons should command a ready sale in large quantities, but the prices will be largely influenced by those ruling for Peruvian, which variety they somewhat resemble owing to their slightly rough character.*"

"*The ones marked A and B are superior to D and E as regards bloom, and would compete with Texas cotton of the ordinary bread-and-butter type, for which there is generally a steady demand; whereas D and E resemble more the character of Peruvian.*"

"*Its exceptional strength should render it very valuable.*"

"*A very great advantage is the absence of 'Nep' in the cotton; like Peruvians they should lend themselves particularly well to mixing with stapled Memphis.*"

The brokers' staple lengths and valuations (in points on current American futures) are included in Table III. In this table frequency arrays of 500 single hair measurements are given for each strain, for unselected Ishan, for commercial "native" (*Peruvianum*), and for commercial Nigerian Allen cotton. The ginning percentages quoted are those obtained by power saw gins, the property of the B.C.G.A. These figures, in the case of the Ishan cottons, are lower by 3 per cent. to 4 per cent. than those obtained on the hand roller gin, and it was noticed that the naked Ishan seed did not gin cleanly through the saw gins, though these machines are satisfactory for fuzzed seed.

Turning now to Tables IV. and V., we find a progressive increase in mean maximum lint length in all strains up to the 1926-27 season. The figures for this latter season show a general decrease, and it is desirable at this stage to consider the matter in some detail. Possible explanations are as follows:

(*a*) In the case of the selfed progeny of the single-plant selections, the mean length, in the four cases, falls anything from 0·8 to 3 mm. below the parental figure. Such results might be expected from selection within pure lines. The similarity between the lengths of the selfed and multiplied portions of the strains is indicative of approaching purity, and it seems that the stage is being reached where further selection within the strains will prove futile. At least one more season's work will be required to confirm this.

(*b*) In the case of the multiplied populations, the decrease may be due to the greater productivity of the shorter stapled plants, though there is no evidence on which to base this theory. The decrease

TABLE III.—SINGLE HAIR MEASUREMENTS, ETC., OF ISHAN AND OTHER COTTONS.

Strain.	*Class Value (in Millimetres).*														*Mean.*	*Brokers' Staple Length.*	*Brokers' Valuation.*	*Commercial Ginning (per Cent.).*
	6	9	12	15	18	21	24	27	30	33	36	39	42	45				
A	2	3	10	9	27	41	66	89	93	88	52	18	2	—	28·0	$1\frac{1}{8}$ in.	250 on	31·5
B	—	2	4	12	23	42	53	86	96	102	47	26	5	2	28·8	$1\frac{1}{8}$ to $1\frac{3}{16}$ in.	275 on	30·4
D	—	—	5	13	25	31	48	65	85	83	83	54	8	—	30·0	$1\frac{3}{16}$ in.	300 on	30·3
E	—	—	3	10	18	35	40	69	101	96	87	31	9	1	30·1	$1\frac{3}{16}$ to $1\frac{1}{4}$ in.	325 on	27·0
Unselected Ishan	—	—	9	28	38	58	81	88	90	57	44	7	—	—	26·4	—	—	30·0*
"Native" (*Peruvianum*), 1st Grade	—	—	14	20	47	69	77	86	83	59	32	11	2	—	26·1	—	Usually 0 to 50 on	26 to 27
Allen, 1st Grade	—	1	10	20	23	30	59	74	103	79	71	24	3	3	28·7	$1\frac{1}{8}$in.	Usually 100 to 150 on	28 to 30

* Estimated

TABLE IV.—THE PEDIGREE OF THE ISHAN STRAINS.

1924. *Original Field Selections.*	1925.	1926.	1927.
1. (*29*)			
	A (*34·2* / 35%) selfed—	A (Selection) (*37·6* / 34%) selfed—A	(*34·8*)
2. (*31*)—selfed—		A (Remainder) (*36·1* / 33%) multiplied—A	(*34·4* / 35%)
		B (Selection) (*35·8* / 37%) selfed—B	(*35·0*)
3. (*31*)	B (*34·0* / 35%) selfed—		
		B (Remainder) (*35·7* / 32%) multiplied—B	(*34·1* / 32%)
4. (*31*)—selfed—	C (*34·3* / 35%) selfed—	C (*35·1* / 31%) discarded.	
5. (*28*)		D (Selection) (*37·0* / 30%) selfed—D	(*35·0*)
6. (*27*)	D (*34·3* / 31%) selfed—		
		D (Remainder) (*36·2* / 29%) multiplied—D	(*34·6* / 30%)
7. (*31*)			
8. (*26*)			
9. (*30*)			
10. (*30*)		E (Selection) (*38·8* / 28%) selfed—E	(*36·2*)
11. (*31*)—selfed—	E (*34·8* / 30%) selfed—		
12. (*31*)		E (Remainder) (*36·3* / 28%) multiplied—E	(*34·6* / 28%)
13. (*33*)			
14. (*30*)			
15. (*32*)			
16. (*31*)	F (*33·8* / 32%) selfed—	F (*33·2* / 29%) discarded	
17. (*34*)—selfed—			
18. (*30*)	G (*34·1* / 32%) selfed—	G (*33·9* / 29%) discarded	
19. (*31*)			
20. (*30*)			

The figures in italics are the mean maximum lint lengths in millimetres. Roller ginning percentages are also given, excepting those of the original field selections and of the selfed groups of the 1927 crop. New single-plant selections have not yet been made from the latter.

TABLE V.—FREQUENCY ARRAY OF MAXIMUM LINT LENGTH: SELECTION PLOT 1926–27.

SHOWING APPARENT REGRESSION FROM THE PARENTAL VALUE.

Strain.	*Class Value (in Millimetres).*																				*Number of Seeds Measured.*	*Mean Maximum Lint Length.*	*Standard Deviation.* σ	*Coefficient of Variability (C.).*
	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44				
A	—	2	6	21	22	106	185‡	394	564	609†	1,016	677	489	319*	123	75	10	2	—	—	4,620	34·8	2·28	6·6
B	—	—	2	4	5	70	85‡	188	310	321†	527	425*	289	183	83	74	9	3	2	—	2,580	35·0	2 32	6·6
D	—	1	4	7	13	58	75‡	172	292	390†	634	497	365*	187	67	26	2	—	—	—	2,790	35·0	2·1	6·0
E	1	1	2	6	10	33	37‡	56	108	164	467†	406	527	369	164*	134	17	1	1	1	2,505	36·2	·23	6 2

* Signifies Parental Value (1925–26)

† ,, Grand Parental Value (1924–25).

‡ ,, Great Grand Parental Value (1923-24).

cannot be assigned to genetic causes, for all the seed sown had been selfed. The behaviour of these multiplied strains during the coming season will be of the utmost interest, for if the lines are not pure, deterioration will be inevitable, quite apart from that caused by accidental adulteration with other cotton.

(*c*) Climatic differences between the seasons 1925-26 and 1926-27 may be responsible. The former season was characterized by an early cessation of the rains, and the bulk of the crop was both laid down and matured during a period uninterrupted by rainfall. In the latter season several showers occurred during the maturation of the crop. This explanation is far more feasible than (*b*) in accounting for the apparent deterioration of the strains under multiplication, but since the selfed progeny of the single plant selections showed a still greater decrease from the mean parental values, it seems likely that regression in their case is an additional factor.

Future Work.

The stage has now been reached with the multiplied strains when it has become imperative to reduce the number to one or, at the most, two prior to distribution. The choice of a single strain from the four is not an easy task, for the most prolific are the least valuable. However, it seems that the poor yield of D and the low ginning percentage of E more than discount the higher premia commanded by these cottons. Moreover, it is important that the strain to be distributed should be its own propaganda, and the big bolls of A and B, in addition to the facilitation of picking, render these plants more attractive to the eye than strains D or E, which possess small bolls. Finally, the latter, in particular strain E, are highly susceptible to leaf curl, while A and B are practically immune. Thus the choice seems to be restricted to A and B. These two sister strains closely resemble one another in all characters, and cannot be distinguished in the field. The staple length of B is slightly superior to that of A, but the latter has the higher ginning percentage. The yield test in 1925-26 showed B to be the more prolific, but in the 1926-27 season, although no figures are available, it appeared that A was superior to B. In view of the similarity and close relationship between the two, it has been decided to multiply both as much as possible during the coming season, pending yield tests on a field scale. Ultimately one will be withdrawn. Selection within strains A, B, and E will be continued for at least another season, but strain D will be discarded. The isolation and testing of new strains will, of course, be continued. It

is anticipated that the maintenance of purity in these cottons after distribution will prove impracticable, and that for many years considerable adulteration with *G. Peruvianum* will be inevitable. Unfortunately the latter cotton is practically indistinguishable from *G. vitifolium*, and roguing on a field scale is impossible. Moreover, on account of the local consumption, much seed never reaches the ginneries at all, thus the elimination of the "native" cotton will be a lengthy process. However, the suitability of the improved cotton to the local system of agriculture and, for West Africa, the unprecedented value of the crop, should rouse the enthusiasm of the farmer; thus by maintaining a continuous supply of pure seed from seed farms, by a judicious system of grading and marketing, and by the destruction at ginneries of badly adulterated seed, the task should eventually be accomplished and a revolution effected in the cotton industry of Southern Nigeria.

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Received May, 1927.

COTTON STATISTICS.—XI

COMPILED BY

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THE Supplementary Report on the Indian crop was published on April 23, and enables us to bring down to date the record of the Indian crop history which is given below. It will be seen that all the figures for 1926-27 show a sharp drop. The acreage has been substantially reduced, for the first time since 1921, and the yield per acre is the lowest since 1920. When giving this table in July, 1926, we referred to the very high average yield of the previous five years, and suggested the hope that the rapid development of the long-staple sections was the cause of this, and that this might be expected to be permanent. This year's figures are therefore all the more disappointing because, as will be seen from Table II. (Indian Cotton Crop by Varieties), it is the long-staple sections that have suffered most this year, with the result that for the first time since 1921 the average yield of the long-staple districts is lower than in the short-staple areas.

With regard to this table Mr. B. C. Burt of the Indian Central Cotton Committee published last year a revised table, in which he corrected our allocation of the various districts according to staple —*e.g.*, by transferring Cocanada from long staple to short, and also from his own personal knowledge transferring part of the Barsi and Nagar and Hyderabad-Gaorani and Broach crops to short staple. The result was to reduce by about 400,000 to 500,000 bales our total figure of long staple. In the table we have given effect to the correction regarding Cocanada back to 1915-16. Unfortunately, Mr. Burt's corresponding figures for this season are not available, but, making a similar allowance, it appears that India has produced during the past season about 1½ million bales of ⅞-inch staple or above, as against 2 millions in the previous season. This point is of interest in view of the very large imports of American cotton into India during the current season.

In the April issue we gave the history of the Egyptian crop, and we now repeat the corresponding table of the area by varieties. Unfortunately, however, some doubt has been thrown on the whole question of the area statistics by the fact that the 1926 crop is quite evidently going to exceed the estimates of last autumn by a substan-

tial amount. At the beginning of June, the arrivals at Alexandria had exceeded the corresponding figure at the same date last year by as much as 800,000 kantars, the total being over 8,300,000 kantars. It is more than likely therefore that the crop will exceed 8½ million kantars. As this would indicate on the government acreage figures an average yield of over 4¾ kantars per feddan (a figure which has not been equalled since 1903-04), and no explanation has been forthcoming of such an increase of the yield, one is almost forced to the conclusion that the acreage must have been larger than the government figures indicated.

TABLE I.—INDIAN CROP, AREA, YIELD, AND PRICE, 1914–1926.

Seasons.	*Area (Acres).* 000's.	*Crop (Bales of 400 Lbs.).* 000's.	*Yield per Acre. (Lbs.)*	*Net Exports and Consumption.* 000's.	*Season's Average Prices.*	
					No. 1 Fine Oomra.	*Per Cent. on American.*
1914–15 ..	24,595	5,209	85	4,889	4·46	85
1915–16 ..	17,746	3,738	84	5,109	6·09	81
1916–17 ..	21,745	4,489	83	4,985	10·32	84
1917–18 ..	25,188	4,000	64	4,499	18·78	87
1918–19 ..	20,997	3,972	76	3,991	18·13	92
1919–20 ..	23,352	5,796	99	5,343	19·23	76
1920–21 ..	21,340	3,600	67	4,941	9·20	77
1921–22 ..	18,451	4,485	97	5,972	9·60	85
1922–23 ..	21,804	5,073	93	6,270	11·14	75
1923-24 ..	23,631	5,161	87	5,946	13·35	74
1924–25 ..	26,801	6,088	91	6,923	11·95	87
1925–26 ..	28,491	6,250	88	6,508	8·97	83
1926–27 ..	24,976	4,973	80	—	—	—

TABLE II.—INDIAN COTTON CROP: AREA, CROP, AND YIELD PER ACRE BY VARIETIES.

(000's *Omitted Throughout in Area and Crop Figures.*)

Varieties.	1915–16.			1916–17.			1917–18.			1918–19.		
	Area (in Acres).	*Crop (Bales of 400 Lbs.).*	*Yield per Acre (Lbs.).*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*
I. *Mainly under $\frac{7}{8}$ Inch Staple :*												
Oomra (Khandeish, Central India, Berar, and Central Provinces)	6,282	1,662	106	7,331	1.342	73	7,477	899	48	6,766	1,169	69
Dhollera	1,180	150	51	2.061	585	114	3,413	680	80	1,775	118	27
Bengal Sind (United Provinces, Rajputana, Sind Punjab, etc.)	2,262	591	105	3,163	930	120	4,066	669	66	3,146	880	112
Comilla, Burma, etc.	329	68	83	351	75	85	379	94	99	497	116	93
Coconada	251	35	56	275	48	70	261	29	44	272	51	75
Total under $\frac{7}{8}$ inch staple	10,304	2,506	97	13.121	2,980	91	15,596	2,371	61	12,456	2,334	75
Per cent. of total crop	58·1	67·0	—	60·3	66·2	—	62·0	59·3	—	59·2	58·6	—
II. *Mainly $\frac{7}{8}$ Inch Staple and Above :*												
Broach	1,044	230	88	1.226	304	99	1,346	314	93	1,363	169	50
Coompta Dharwar	1,031	231	90	1.385	260	75	1,781	356	80	1,551	252	65
Western and Northern	1,350	172	51	1.583	238	60	1,596	169	42	1,812	232	51
Tinnevelly	568	84	59	647	134	83	577	99	69	} 1,385	344	99
Salem and Cambodia	281	32	46	334	47	56	649	217	134			
Barsi and Nagar	3,168	483	61	3,449	539	62	3,643	474	52	2,471	647	105
Hyderabad Gaorani					(Included in Barsi and Nagar)							
Total $\frac{7}{8}$ inch staple and above ..	7,442	1,232	66	8.624	1,522	71	9.592	1,629	68	8,582	1,644	77
Per cent. of total crop	41·9	33·0	—	39·7	33·8	—	38·0	40·7	—	40·8	41·4	—
Grand total	17,746	3,738	84	21,745	4,502	83	25,188	4,000	64	21,038	3,978	76

TABLE II.—INDIAN COTTON CROP: AREA, CROP, AND YIELD PER ACRE BY VARIETIES.—*Continued.*

(000's *Omitted Throughout in Area and Crop Figures.*)

Varieties.	1919–20.			1920–21.			1921–1922.			1922–23.		
	Area.	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*
I. *Mainly under ⅞ Inch Staple :*												
Oomra (Khandeish, Central India, Berar, and Central Provinces)	7,663	1,953	101	7,119	844	47	6,686	1,643	99	7,679	1,627	85
Dhollera	2,205	510	93	2,408	453	75	1,845	455	99	2,014	489	97
Bengal Sind (United Provinces), Rajputana, Sind Punjab, etc.)	4,453	1,366	123	4,164	1,093	105	2,280	622	109	2,428	695	74
Comilla, Burma, etc.	787	165	84	507	81	64	459	72	63	419	78	74
Coconada	28	3	43	240	42	70	212	42	79	279	55	79
Total under ⅞ inch staple	15,136	3,997	106	14,438	2,513	70	11,482	2,834	98	12,819	2,944	92
Per cent. of total crop	64·8	68·8	—	67·6	69·8	—	62·5	63·2	—	58·9	58·0	—
II. *Mainly ⅞ Inch Staple and Above :*												
Punjab (American)	—	—	—	—	—	—	401	79	79	382	117	123
Sind (American)	—	—	—	—	—	—	(Included	under Si	nd Punjab)	7	4	229
Broach	1,283	308	96	1,273	199	63	949	168	71	1,130	281	99
Coompta Dharwar	1,318	296	90	1,301	216	66	926	212	92	1,130	189	67
Western and Northern	1,766	274	62	1,431	147	41	1,125	142	50	1,657	167	40
Tinnevelly											141	
Salem	956	234	98	948	242	102	894	238	106	1,048	23	112
Cambodia											130	
Barsi and Nagar	1,736	352	81	1,057	162	61	1,549	386	100	2,180	628	115
Hyderabad Gaorani	1,158	335	116	893	122	55	1125	420	149	1,439	451	125
Total ⅞ inch staple and above ..	8,217	1,799	88	6,903	1,088	63	6,969	1,645	95	8,973	2,131	95
Per cent. of total crop	35·3	31·2	—	32·4	30·2	—	37·5	36·8	—	41·1	42·0	—
Grand total	23,353	5,796	99	21,341	3,601	67	18,451	4,479	97	21,792	5,075	93

TABLE II.—INDIAN COTTON CROP: AREA, CROP, AND YIELD PER ACRE BY VARIETIES.—*Continued.*

(000's *Omitted Throughout in Area and Crop Figures.*)

Varieties.	1923–24.			1924–25.			1925–26.			1926–27.		
	Area.	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*
I. *Mainly under* $\frac{7}{8}$ *Inch Staple :*												
Oomra (Khandeish, Central India, Berar, and Central Provinces)	7,891	1,552	79	8,768	1,674	77	8,970	1,633	73	8,278	1,483	72
Dhollera	2,127	311	58	2,578	628	97	3,173	630	79	2,452	563	92
Bengal Sind (United Provinces, Rajputana, Sind Punjab, etc.)	2,847	862	121	3,671	1,070	117	3,873	1,080	112	3,357	829	99
Comilla, Burma, etc.	440	85	77	497	112	90	696	159	91	667	151	91
Coconada	263	51	78	291	57	78	304	54	71	201	28	56
Total under $\frac{7}{8}$ inch staple	13,568	2,861	84	15,805	3,541	89	17,016	3,556	84	14,955	3,054	82
Per cent. of total crop	57·4	55·4	—	59·1	58·2	—	59·7	57·0	—	59·9	61·4	—
II. *Mainly* $\frac{7}{8}$ *Inch Staple and Above :*												
Punjab (American)	604	235	156	964	363	151	1,148	359	125	1,135	221	78
Sind (American)	5	3	240	16	4	100	7	2	114	25	5	80
Broach	1,233	215	70	1,355	345	102	1,413	331	94	1,205	222	74
Coompta Dharwar	1,696	254	60	1,951	333	68	1,729	317	73	1,721	222	52
Western and Northern	1,949	182	37	2,199	345	63	2,233	385	69	1,576	147	37
Tinnevelly	611	157	103	621	164	106	705	180	102	584	145	99
Salem	211	25	47	235	32	54	194	36	74	188	32	68
Cambodia	369	151	164	442	183	166	415	155	149	323	123	152
Barsi and Nagar	1,990	579	116	3,213	778	97	3,631	929	102	3,264	802	98
Hyderabad Gaorani	1,400	500	143									
Total $\frac{7}{8}$ inch staple and above ..	10,068	2,301	92	10,996	2,547	93	11,475	2,694	94	10,021	1,919	76
Per cent. of total crop	42·6	44·6	—	40·9	41·8	—	40·3	43·0	—	40·1	38·6	—
Grand total	23,636	5,162	87	26,801	6,088	91	28,491	6,250	88	24,976	4,973	80

TABLE III.—EGYPTIAN CROP: AREA BY VARIETIES.

	1913.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.	1925.	1926.
Sakel ..	247.292	394,403	547,923	1,032,140	1,133,180	952,481	1,146,443	1,270,481	995,479	1,358,162	1,255,000	872,624	1,128,946	981,783
Per cent.	14·4	22·4	46·2	62·4	67·5	72·5	72·9	69·5	77·0	75·4	73·2	48·8	58·8	55·0
Ashmouni	356,485	353,882	231.639	343,589	361,874	273,936	334,160	283,906	170,514	276,193	310,150	796,362	270,842	667,474
Per cent.	20·7	20·2	19·5	20·7	21·6	20·8	21·3	15·5	13·2	15·3	18·1	44·5	14·1	37·4
Zagora ..	—	—	Not separately		recorded	—	—	97,612	92,536	126,541	102,390	—	388,578	—
Per cent.	—	—				—	—	5·3	7·2	7·1	6·0	—	20·2	—
Pilion ..	—	—	,,	,,	,,	—	—	—	319	20	*	49,960	72,799	102,394
Per cent.	—	—				—	—	—	0·02	—	—	2·8	3·7	5·7
Afifi ..	623,737	467,350	209,550	141,446	96,675	36,240	35,145	44,068	6,771	8,202	6,050			
Per cent.	36·3	26·6	17·6	8·5	5·8	2·7	2·2	2·4	0·5	0·5	0·3			
Assili ..	65,958	134,104	49,545	66,602	38,008	20,736	21,003	30,051	5,839	7,863	7,820	22,271	8,384	4,234
Per cent.	3·8	7·7	4·2	4·0	2·3	1·6	1·3	1·6	0·45	0·4	0·5	1·3	0·4	0·2
Abassi ..	37,383	12,281	7·468	3,391	3,480	4,871	3,718	12,558	1,267	2,274	*			
Per cent.	2·2	0·7	0·6	0·2	0·2	0·4	0·2	0·7	0·1	0·2				
Jannovitch	173,439	127,531	28,908	4,220	1,592	223	97	2,087	300	225	*			
Per cent.	10·1	7·3	2·5	0·3	0·1	0·02	—	0·1	0·02	0·02				
Nubari ..	201.137	261,775	106,634	62,127	39,339	21,587	23,611	37,320	8,645	11,090	10,660	46,626	54,833	29,817
Per cent.	11·7	14·9	9·0	3·8	2·3	1·6	1·5	2·0	0·7	0·6	0·6	2·6	2·8	1·7
Others ..	17,663	3,944	4,337	1,997	3,153	5,498	9,485	49,787	10,208	10,273	23,080			
Per cent.	1·0	0·2	0·4	0·1	0·2	0·4	0·6	2·7	0·8	0·5	1·3			
Totals ..	1,723,094	1,755.270	1,186,004	1,655,512	1,677,310	1,315,572	1,573,662	1,827,870	1,291,878	1,800,843	1,715,150	1,787,843	1,924,382	1,785,702

* Included in Others.

EMPIRE COTTON CROPS FOR EIGHT YEARS 1919–26, EXCLUDING INDIA.

(*In bales of 400 lbs.*)

Country.	1918–19.	1919–20.	1920–21.	1921–22.	1922–23.	1923–24.	1924–25.	1925–26.	1926–27. Estimates.
(1) Anglo-Egyptian Sudan ..	15,997	23,160	30,519	24,074	28,306	47,652	44,912	121,131	131,750 (1)
(2) Gold Coast	52	—	61	49	15	93	1,132	1,218	* (2)
(3) Nigeria	17,500	16,200	30,000	15,096	16,811	25,694	39,137	47,909	25,000 (3)
(4) Uganda	36,530	47,694	81,365	48,290	88,046	128,604	196,038	180,859	130,000 (4)
(5) Kenya	100	100	500	417	1,200	1,653	2,250	2,046	1,500 (5)
(6) Nyasaland	2,591	2,026	4,615	5,422	4,036	6,873	7,718	4,976	4,000 (6)
(7) Northern Rhodesia.. ..	56	35	100	80	102	500	379	495	363 (7)
(8) Southern Rhodesia.. ..	—	—	—	—	—	1,650	4,907	6,803	1,250 (8)
(9) Tanganyika	—	—	7,500	7,327	7,175	11,434	18,793	21,674	24,550 (9)
(10) Union of South Africa and Swaziland..	1,911	2,737	2,923	2,740	6,523	8,730	16,936	20,381	* (10)
(11) West Indies..	6,137	6,205	4,833	4,113	5,254	4,290	4,184	5,671	* (11)
(12) Queensland	31	38	792	3,140	9,344	11,850	14,318	7,208	4,300 (12)
(13) Cyprus	1,000	3,325	2,687	2,547	1,505	2,233	3,397	3,320	* (13)
(14) Malta	315	343	266	582	193	118	573	782	507 (14)
(15) Iraq	—	—	60	60	300	1,100	2,400	2,540	3,000 (15)
(16) Fiji	—	—	—	—	83	153	123	122	788 (16)
(17) Ceylon	—	—	—	—	49	324	121	261	140 (17)
	82,220	101,863	166,221	113,937	168,942	252,951	357,318	427,396	
		Percentage Increase 24·0.	*Percentage Increase* 63·1.	*Percentage Decrease* 31·4.	*Percentage Increase* 48 2.	*Percentage Increase* 49·7.	*Percentage Increase* 41·2.	*Percentage Increase* 19·6.	

* Estimates not yet received.

NOTES ON CURRENT LITERATURE

COTTON IN INDIA.

312. Cotton Cultivation in India. (Abstr. from *Daily News*, March 4, 1927.) The acreage under cotton has been reduced owing to the fall in prices, and the crop is not expected to exceed 5,000,000 bales. Luckily the quality of the present crop is, on the whole, quite good, and keen competition between Japanese and Indian buyers has maintained the price at levels which, though disappointing to the cultivator, are not likely to land him in actual loss.

313. Cotton in Mysore. (Abstr. from the *Ann. Rpt. of Agr. Dept.*, 1925-26.) It is stated that Selection No. 69, bred on the Babbur Farm, and known as the "Babbur Farm Cotton," has proved very successful. From 1,500 acres planted in 1924-25 it has increased to 10,000 acres at the present time. This cotton is a very good type for dry localities, but is not so successful in wet districts.

314. Indian Central Cotton Committee. From a report received from the Secretary, we learn that at the Fourteenth meeting held in January an interesting discussion arose on the reports of the investigations made in Khandesh, Berar, and North Gujarat into the finance of the cotton crop. Each cotton-grower, in the villages chosen as representative of the tracts concerned, was asked exactly how he had obtained his finance, how much cotton he had grown, how and when he disposed of it, and at what rates. The local cotton markets were also visited, and the details recorded of the market customs, rates, allowances, etc., the disposal of many hundreds of carts of kapas being followed up in detail. Replies as to their needs and difficulties in regard to the marketing of their cotton were received from some 2,300 growers. The opinion generally held, that the cotton-grower is forced to rush his kapas to market through want of finance, is not supported by the investigations: on the contrary, a considerable proportion of the 1925-26 crop remained in the hands of the growers until a comparatively late date. Moreover, it was demonstrated that though, as is well known, growers required considerable financial help during the growing period, they were not hampered by their borrowings in the disposal of their produce to the best advantage. In two of the tracts the financing agencies, generally speaking, were not purchasers of kapas. In the regulated cotton markets of Berar, where 46·1 per cent. of the recorded crops were sold by the cultivators themselves in those markets, the growers obtained much better information of current market rates than elsewhere. In Khandesh, where the markets are unregulated, a smaller proportion of the growers used them, and there was far less knowledge of current rates. For the markets fully to achieve their purpose it is necessary that the growers be well represented on the managing committees. Another important indication obtained from the evidence was that growers would benefit greatly by proper warehousing facilities for kapas in the markets.

It was decided that similar investigations to those described above should be commenced in 1927-28 in Sind, the Punjab, the Madras Northerns and Westerns cotton tract, and Middle Gujarat.

315. Studentships. At the Meeting of the Indian Central Cotton Committee held in January, eight Research Studentships, for the study of the technique of scientific investigations on cotton-growing, were awarded to graduates of Indian Universities.

316. Indian Cotton Pressing Factories: Location. (*Ind. Trade J.*, Supplement, January 13, 1927, p. 21. Abstr. from *Summ. of Curr. Lit.*, vol. vii., 8, 1927, E. 30.) A list is given of names, location, owners and officially allotted press marks of the cotton pressing factories in British India for 1926-27.

317. The Eradication of Kans Grass (*Saccharum spontaneum*, L.). By A. Howard. (Abstr. from *Agr. J. of India*, vol. xxii., 1, 1927, p. 39.) One of the chief obstacles to the growth of cotton and other crops in Central India, Bundelkhand, and parts of the Central Provinces is a perennial deep-rooted grass known as *kans*. At a conservative estimate the reduction in the yield of cotton caused by this weed is at least a third of the crop. The implements at the disposal of the cultivator only serve to keep *kans* in check, they do not eradicate it. Attempts are now being made in some parts of India to bring this pest under control by means of tractors, but the method is expensive and not very suitable for the ordinary villager. Soil inversion is not necessary in India, with its drought and sunlight, and use was made of an adjustable *bakhar*, capable of working to a depth of 8 to 9 inches, drawn by two pairs of oxen *walking abreast*. This *bakhar* was obtained by dismantling and slightly altering the P. and O. 10-inch ridging plough, manufactured by the International Harvester Company, and on sale in India at Rs.40. The broad share of this plough, when the wings and sole are removed, acts as a very efficient and self-cleaning bakhar blade, and uproots the dense mass of *kans* rhizomes which run mostly in the upper 8 inches of soil. One of these subsoilers will plough an acre of land a day at a cost somewhat below Rs.5.

318. Ridge Cultivation in Lower Gujarat. By B. M. Desai and K. B. Naik. (*Bombay Dpt. Agr., Bull.* 123, 1925. Abstr. from *Exp. Sta. Rec.*, vol. lvi., 1, 1927, p. 76.) Describes the ridge method of cultivation of cotton and sorghum, and the results of experiments in its application to the black soil tracts in lower Gujarat are presented. With judicious cultivation between the ridges the yield of cotton can be raised either in wet, dry, or normal years by an average yield of from 23 to 25 per cent. The experiments showed that ridge cultivation affords good surface drainage, and prevents the land from becoming partially water-logged in the upper 8 to 10 inches during the period of heavy rain. The amount of weeding in ridged plats was found to be considerably less than on the flat, but the experiments were made on fairly clean fields. The root development of cotton was deeper on the ridged plats, and this system of cultivation was found to permit of late intertillage. In the early stages of growth the crop on ridges remained green, while that on the flat became yellow during heavy rain. It was possible to work the soil on the ridges after heavy rains much earlier than on the flat.

[*Cf.* Abstr. 222, p. 164.]

COTTON IN THE EMPIRE (EXCLUDING INDIA).

319. The following Reports have recently been received:

Mysore. "Annual Report of the Agricultural Department, 1925-26."
Nigeria. "Fifth Annual Bulletin of the Agricultural Department, 1926."
Tanganyika. "Report of the Department of Agriculture, 1926."
The Imperial College of Science and Technology. "Nineteenth Annual Report, 1926."

320. Agricultural Research and Administration in the Non-Self-Governing Dependencies. Report of a Commission appointed by the Secretary of State for the Colonies, Cmd. 2825. London, 1927. Stationery Office. 2s. net.

The Commission whose report is here presented was appointed to consider the questions of recruitment and training of officers for agricultural departments

in the non-self-governing dependencies (such as Ceylon, Nigeria, etc.), and of improving the supply and obtaining higher efficiency. The report is worth careful perusal, and it is a great compliment to the work of the Empire Cotton Growing Corporation that the chief recommendations proceed along the lines already followed by that body. Serious difficulty has been found since the war in obtaining sufficient and satisfactory recruits, and this is put down to a general lack of interest in the development of these colonies, in spite of the fact that they form one-sixth of the area of the Empire, with a population of 50 millions, whilst their trade with Great Britain has quadrupled in value during the last twenty years.

In view of the fact that these dependencies are, and are likely long to remain, chiefly agricultural, it is looked upon as certain that with their increasing importance there will be an increasing demand for agricultural officers, a proper supply of whom may therefore be regarded as of prime importance to their, and the Empire's, welfare. Briefly, the scheme which is put forward is upon the lines of the system employed by the Empire Cotton Growing Corporation—the establishment of a number of post-graduate scholarships whose incumbents shall spend one year in this country and one at the Imperial College in Trinidad. This scheme was proposed in an interim report, and is already definitely launched, while in the meantime trained students are being obtained through the good offices of the Corporation. By this means it is hoped to form a kind of reservoir from which the colonial appointments, which vary in number from year to year, may be filled up with well-trained men, who have already had at least a year of experience in the tropics under careful guidance.

Part II. of the report deals with the collection and dissemination of information, which is considered to be lacking in efficiency. A kind of clearing house for the accumulation, abstracting, and publication of all information about research and other work is recommended, on the lines of the Imperial Bureaux of Mycology and Entomology. Cotton is excepted from the subjects dealt with, as already treated in this Journal.

Part III. goes on to the organization of research, and is a majority report. A chain of central research stations—two of which already exist, in Trinidad and Amani—to be gradually established, is proposed, with a central Advisory Council in London. The central stations should be staffed by first-class men, and deal with general problems affecting the whole area which they serve. The Council should be a permanent official body, botany, entomology, and mycology being represented by the Directors of Kew and the Imperial Bureaux, whilst the chairman, who should be a distinguished man of science, and the secretariat, should be full-time officers. This body would be kept informed of all research work being done in the colonies concerned, and would exercise criticism and suggestion, whilst the chairman should travel into the various colonies at intervals to see at first hand what is going on.

Finally, conditions of pay and service are considered, and it is thought that these should be improved, especially for the specialist and research officers, who will not in general be eligible for the higher administrative posts.

321. Agricultural Conference, Nairobi, 1926. We have recently received a copy of the Proceedings of the South and East African combined Agricultural, Cotton, Entomological, and Mycological Conference, convened by the Secretary of State for the Colonies, and held at Nairobi, Kenya Colony, in August, 1926. The chief object for which the Conference was called was to provide an opportunity for co-workers on agricultural problems in Africa to meet each other, and thus obtain the acknowledged benefit from consultation and discussion which such occasions presented.

The conclusions arrived at by the Cotton Section and the Entomological and Mycological Section are summarised as follows:

COTTON SECTION: 1. *Technique of Field Experiments.*—That whatever method of field experiments was used it should be so designed as to permit the degree of accuracy being determined.

Attention was also called to the inaccuracy which may be involved in comparing varieties which are different in habit and which may, therefore, be differently affected by the cultural conditions adopted—*e.g.*, uniformity of spacing for large and small types is obviously unsound.

2. *The Keeping and Utilization of Records.*—That the keeping and utilization of records with regard to the Cotton plant and its yield necessitates Experimental Stations being adequately equipped.

3. *The Position with Regard to Cross Breeding.*—That crossing ought to be valuable, but in practice it does not appear to be so. If crossing is to be of value, an early start should be made, since a long time elapses before any results are achieved.

4. *The Treatment of Seed before Sowing.*—That the Sulphuric Acid treatment for seed for delinting should be fully investigated by some central institute, if local investigation proved insufficient.

5. *Mass Methods for Maintaining and Improving the Quality of Cotton in the Districts.*—That mass selection must be only a temporary measure during the time necessary to establish pure strains.

6. *Interchange of Strains between African Countries.*—(*a*) That the Empire Cotton Growing Corporation be asked to prepare and publish, and keep up to date, a list of all varieties and strains of cotton in cultivation throughout the world, with a description of the characteristics of each variety, and the conditions under which it is grown.

(*b*) That with a view to guarding against the disappearance of any particular strain, showing specialized qualities, such should be stored locally against possible requirements.

(*c*) That a uniformity of nomenclature of strains in Africa is advisable; so far as South and East Africa are concerned, it was considered that new productions should be distinguished by the name of the producing station, followed by a distinguishing number or letter, or both.

7. *Introduction of New Varieties from Countries Outside Africa.*—(*a*) That much benefit would accrue from the broadening of the basis of selection by the introduction of promising varieties from outside, especially from America.

(*b*) That the Empire Cotton Growing Corporation be asked to assist Plant Breeders in obtaining such varieties as they may require.

8. *Methods of Testing New and Improved Strains of Cotton in Different Parts of the Country.*—That it is useless to arrange for tests and records unless these are accurately carried out under the supervision of the Agricultural Department. Inspections, with notes, should be made as frequently as possible, and, in any case, at intervals not greater than one month; regular periodic pickings should also be made, if possible. Where sufficiently competent men are in charge, meteorological records should also be kept.

9. *Cotton Tax.*—That it is desirable that, in the imposition of a Cotton Tax, the principle of a graduated tax, having regard to the market price of cotton, be adopted.

ENTOMOLOGICAL AND MYCOLOGICAL SECTION: *Cotton Pests.*—1. That the *Platyedra erebodoxa*, Meyr (M. S.), discovered by Mr. Hancock, shows no indication of becoming a pest of cotton in Uganda.

2. (*a*) That steps be taken to secure from each African territory a report upon the presence or absence of Pink Boll Worm therein, together with a carefully prepared map showing the different cotton-growing districts, and, if Pink Boll Worm is present, the areas known to be infested.

(*b*) That, from the information so supplied, a map of Africa be prepared for the use of African Entomologists, showing the distribution of cotton cultivation and of Pink Boll Worm.

(*c*) That the delegation from South Africa, as represented by the Government officials and the officials of the Empire Cotton Growing Corporation, be asked to initiate this project and secure the publication in South Africa of the desired map for distribution.

3. That, although a great deal of experimental and investigational work has been done on Sudan, American, and Spiny Boll Worm, this Section is not in a position to make any general recommendations. No economic means of control have yet been devised, but the Section is of opinion that further investigations are desirable and necessary.

4. That there is danger of *Apion* becoming a serious pest if uprooting and burning is not resorted to, and that in Tanganyika uprooting and burning has been found to be entirely successful.

5. That the status of the wild food plants of the Sudan Boll Worm is of great importance, and calls for further thorough investigation.

6. That the control of *Aphids* and *Jassids* by fungi should be further investigated.

7. That a wider survey is necessary before any definite information can be supplied in regard to the natural occurrence of major pests, and their occurrence under conditions of cultivation.

8. That, in view of the immense importance of Cotton Staining and Internal Boll Rots to the future development of cotton-growing in Africa, it is recommended:

(*a*) That thorough investigations should be undertaken into the problem, with special reference to the possible rôle played in transmission by Dysdercus and other suctorial insects.

(*b*) That in some one centre an adequate staff should investigate thoroughly the whole problem in all its aspects, and that the Government of South Africa should be approached, in the first instance, with a view to undertaking this work.

(*c*) That the programme of the work to be adopted should be drafted by the staff of the centre chosen for the major investigations.

(*d*) That this programme should be circulated to the Departments of Agriculture in other cotton-growing areas, with a view to complementary work being undertaken by them.

322. British Colonial Competition for the American Cotton Belt. By L. Bader. (Abstr. from *Econ. Geography*, iii., 2, 1927.) The author begins by quoting from Professor Todd's tables of April, 1926, showing that while the United States is still by far the largest producer of cotton, her percentage of the world's total crops has diminished. This is in a large measure due to a movement, which has behind it the force of the manufacturing industry of Lancashire, to increase cotton production in the British Empire.

The work of the British Cotton Growing Association and the formation and work of the Empire Cotton Growing Corporation are first described. The various countries in which cotton-growing is already of importance—*i.e.*, India, Egypt, and the Sudan—are then reviewed; Uganda and Nigeria, and other producing countries in Asia, South America, etc., are dealt with, and the importance of the transportation problem is stressed. The author goes on to point out where the reality has fallen short of expectation; he anticipates, however, a steady progress, which in the next twenty-five years may raise the crops (from the British Empire and Egypt) from 8 million bales (as at present) to 11½ million bales. He concludes that though England may ultimately supply her mills solely with Empire-grown cotton, the supremacy of the United States as a cotton-growing nation is not

challenged, though owing to the national need of other countries to sustain themselves by drawing more on their own lands, she may have to face a diminution in the call for her raw cotton from foreign countries, and will probably supply only 40 to 50 per cent. of the world's cotton needs, instead of from 50 to 60 per cent. as at present.

The paper is one of the best contributions to the literature on the subject that we have seen.

323. ASIA: CEYLON. *Cotton Growing in Hambantota, Ceylon.* By G. Harbord. (Abstr. from *Ceylon Observer*, March 19, 1927.) An account of the work of the Southern Division in connection with cotton and other dry-land crops, given under the following heads: The production of improved seed; development of cultivation in a more settled form by the consolidation of chenas; investigations into the utilization of rotation crops; marketing of the produce.

324. *Cotton Cultivation in the Hambantota District.* By G. Harbord. (Abstr. from *Year Book of Dpt. of Agr., Ceylon*, 1927, p. 31.) The attempts to establish cotton as an economic crop in the Hambantota District have been continued, and the results are on the whole encouraging. During the season 1925-26 Cambodia seed obtained through the Madras Department of Agriculture was distributed, and germination was satisfactory. The total yield of seed cotton was 2,700 cwts.

Cultivation methods were generally satisfactory, the majority of the cultivators, who are very interested in the crop, realising the importance of clean weeding and earthing up, but insufficient attention was given to "thinning out," and it is clear that further experiments will have to be made in spacing. The author is of opinion that cotton cultivation, in order to become permanent in the Hambantota district and to be of real economic value, should form part of a system of rotation with food and other crops. Favourable opportunities exist at Hatagala and Welipatanwila for a simple crop rotation scheme, and for the early introduction of light ploughs.

The following pests and diseases were noted during the year, which, on the whole, was comparatively free from any serious attacks: leaf roller, pink bollworm, spotted bollworm, cotton stainers, stem borer, scale insects, and mildew and leaf-spot diseases.

325. AFRICA. *Transport in Africa.* (Abstr. from *The Times*, April 12, 1927.) In a letter written by Mr. R. H. Brackenbury to *The Times* it is pointed out that the cost of freight per ton mile carried by motor transport in Africa is about ten times as great as by rail, but the capital cost of providing sufficient railways is prohibitive. It is suggested that some form of motor train, composed of a tractor engine with a train of lorries, may solve the problem. Reference is made to the experiments of the Corporation, and the probability thereby shown that the producer gas engine will prove the most economical way of obtaining power.

326. *Transport in East Africa.* (Abstr. from *East Afr.*, iii., **138**, 1927, p. 1077.) The Isaka-Lohumbo section of the Tabora-Mwanza railway line is now open for public traffic.

327. *Report on the Characteristics of Several Crops that may be Suitable as Rotation Crops with Cotton in East Africa, and the Possibilities of Marketing them in this Country.* By H. C. Sampson, C.I.E. (Published by the Empire Cotton Growing Corporation, price 1s., post free.) This Report is the result of an enquiry carried out at the request of the Corporation as to the possibility of finding a market for several rotation crops that were tried on the Cotton Experiment Station in Nyasaland. The crops are divided into four classes—viz., cereals, pulses, oil seeds, and fibres. At present there does not appear to be a market for most of the cereals and pulses, and the author suggests two ways of introducing new varieties:

firstly, by importing them and allowing them to be sold for what they will fetch until such time as the consuming public realise their value and are prepared to pay for this; secondly, by having further tests carried out into the feeding value, and advertising the results.

In dealing with cereals, Mr. Sampson states that white maize succeeds very well at high elevations in Nyasaland, but not so well in the cotton-growing regions. It forms an excellent cleaning and preparatory crop, but harbours the American bollworm, which feeds on the young silk, and is liable to transfer its attentions to cotton when this is exhausted. *Sorghum vulgare* grows well up to 2,000 feet, and fetches a higher price than maize, but is not so good as a rotation crop. Bulrush millet (*Pennisetum typhoideum*) is considered the best as a rotation crop: cotton does well after it; it does not harbour cotton pests, and it matures early so that the land can be properly ploughed for cotton. The disadvantage is that it brings a very low price, as millets are regarded with suspicion on the market because of high fibre content. *Eleusine coracana* suffers from the same disadvantage, with less compensation.

Pulse crops are then considered, and stress is specially laid on the Lima or Madagascar bean (*Phaseolus lunatus*), which fetches good prices on the European market. Under the heading of Oil Seeds groundnuts and *Sesamum* are considered, as well as sunflower, which grows well in Nyasaland, and fetches a good price. Finally, fibres are dealt with, specially jute and *sannhemp*, and it is pointed out that baling presses are already available for these crops. An appendix by Mr. Alfred Wigglesworth gives a report on Nyasaland jute.

The Report should be in the hands of everyone who is interested (as all connected with cotton-growing should be) in the cultivation of rotation crops.

328. NIGERIA. The *Fifth Ann. Bull. of the Agr. Dpt.*, Nigeria, 1926, gives particulars of various experiments with cotton—including spacing, time of planting, manurial and varietal tests—carried out in 1925 at the following stations: Moor Plantation, Ibadan; Ilorin; Samuru Agricultural Station, Zaria; Kano Agricultural Station; Maigana Seed Farm. Tables showing the details of the various experiments are included.

329. *Cotton in Nigeria.* From a "Report on the Cotton Industry for the half-year ending March 31, 1927," recently received from the Director of Agriculture, we learn that the season in Northern Nigeria, according to the rainfall records, has been the most unfavourable one climatically for cotton for twenty-four years, and has resulted in a much lower yield per acre. Nevertheless, in spite of this, Mr. Faulkner records some encouraging features. Not only on the well-manured plots at the Agricultural Stations, but at the Corporation's Seed Farm at Daudawa, where the soil was being cultivated for the first time, and also on some of the fields owned by natives, the yield of seed cotton was over 300 lbs. to the acre. Fields which were not well cultivated, and which would normally have yielded some 250 lbs. of seed cotton per acre, this year have yielded only 100 lbs. or so. Reports regarding seed distribution are stated to be so far generally encouraging, for the natives still want seed, and are, therefore, presumably proposing to grow considerable areas of cotton next year, notwithstanding the low prices that have ruled, and the abnormal weather conditions experienced, during the season. Three new ginneries have been erected, and a fourth is under construction.

The yield of cotton per acre in the Southern Provinces has been high this season, and it is not anticipated that the total crop will be much lower than that of last year. The grade of the whole crop is, however, generally low, owing to the fact that heavy rains occurred in January and February when the crop was ripening, and when normally no rain falls at all. The Ishan cottons are expected to be of higher grade than the ordinary native cotton. In connection with the introduction of this "new cotton" it is proposed to make special efforts to induce

growers to harvest the crop in two or three pickings, instead of only one as at present. This will lessen the amount of leaf in the seed cotton, which is a bad fault and prevents much otherwise clean cotton from being passed as first grade.

330. NYASALAND. A report recently received from Mr. Ducker states that prospects are good at present with all early planted cotton, especially in the Central Shire and Palombe areas. Little can be said as yet regarding the Lower Shire areas since planting is mainly done in February-April, and the cotton is only at the seedling stage. The rains which have fallen in March are an excellent augury for a good growing season. The low-lying areas of the Lower Shire which have been flooded will require replanting as the floods fall, but provided the fall continues as rapidly as at present and that a further rise does not occur, the planting dates should be normal, and a good crop result. It is reported that the natives of the Ndindo and Lilanja areas were expecting the flood, and it is therefore probable that they have to a large extent delayed planting. Some people are of opinion that the flood which has occurred will tend to increase the area of cotton planted rather than to diminish it. The tendency for cotton to be confined to areas in which it may be grown as a late-planted crop, flowering and fruiting in the dry weather, is even more marked this season than in the past year or two, one reason for this being the better yields and higher grade of lint obtained by the evasion of the main cotton pests. Generally speaking, the cotton prospects for the season are favourable.

331. RHODESIA (SOUTHERN). We have received from the High Commissioner a copy of the *Review of Agricultural Conditions in Southern Rhodesia to January 31, 1927*, by W. E. Meade. It is stated that there was a cessation of the rains in January from the 7th until the 28th, and the position became exceedingly critical, particularly in Matabeleland. Fortunately, general rains broke over the colony on the 29th and 30th of the month, resulting in an average fall over all districts of not less than 1 inch, while many areas received as much as 2½ to 3 inches, spread over three consecutive days. This fortunate break in the weather has entirely altered the agricultural outlook, and provided reasonably good rains are experienced for the next six weeks there is no reason to expect other than very satisfactory results from all crops. The 1925-26 cotton crop yielded 2,721,188lbs. of lint (6,803 bales of 400 lbs.) from 66,086 acres, which is an improvement over the previous year, but shows very clearly the extent to which cotton was affected by the excessive rains.

332. *Cotton Cultivation.* (Abstr. from *Rhod. Agr. Jnl.*, xxiv., **3**, 1927, p. 268.) That cotton can be grown in certain parts of the colony has been amply proved, and it is believed that Southern Rhodesia will in time produce a steady outturn of good-quality cotton. Owing to the heavy rains and to low prices there is a considerable reduction of acreage this season. This in some respects may be well, for a good deal of cotton has in the past been planted in unsuitable localities and at altitudes where the chances of success have been slender. With the experience of the last two seasons behind them, farmers who are planting cotton this season—and the acreage is quite considerable—will select only such areas as afford a reasonable chance of success.

333. SOUTH AFRICA. *Recent Progress in Cotton Growing.* By Lieut.-Col. G. N. Williams, Secretary for Agriculture. (Abstr. from *Sun and Agr. Jnl. of S.A.*, February, 1927, p. 157.) Colonel Williams is of opinion that, assuming that America can go on producing cotton at such a rate as to cause prices to continue indefinitely at their present level, if South Africa can, by increased yields, reduce costs of production so that cotton can be profitably grown at such prices, there would appear to be nothing to stand in the way of the success of the cotton industry, taking into account the quality of the cotton and the price differentiation

in its favour. He states that the whole question is under investigation by the Board of Trade, and the Division of Economics and Markets of the Department of Agriculture is closely investigating costs of production.

334. *Ngotshe Experimental Station, Magut, Transvaal.* (Abstr. from the *S.A. Cott. Growers' Jnl. and Sub-Trop. Planter*, iii., **7**, 1927, p. 5.) This station was established by the Corporation some eighteen months ago mainly for the elucidation of cotton problems, but other aspects of farming in the neighbourhood are not being overlooked. The principal branch of study in connection with cotton is in the selection and improvement of pure strains of seed. In addition, fertilizer trials, spacing, time of planting, and thinning experiments, and investigations to control pests are being carried out, and intercultural trials with cotton and maize, sorghum, beans, and groundnuts are being conducted.

335. SWAZILAND. *Crop Prospects.* (Abstr. from *S. Africa*, April 15, 1927.) The crop prospects of Swaziland promise average returns for tobacco, cotton, and cereals. The season started badly, but good rains and the long planting periods enabled farmers to recover, and today's outlook, in one of the worst years experienced since Europeans have operated in this territory, is good. The cotton crop is promising, as the territory will produce the biggest output since cotton planting was undertaken. Losses from drought in one or two areas are expected, but most crops have given a good growth.

336. *Cotton Crop Prospects in Zululand.* (Abstr. from *The Star*, March 21, 1927.) "Cotton-picking in Zululand is in full swing, and results up to date are very satisfactory. At Ntembanana the crop is reported to be of excellent quality, and superior to anything that has yet been grown in that area. The variety planted was Improved Bancroft, and the staple is stated to be uniform and well up to $1\frac{3}{16}$ inches."

The survey for the new Nkwaleni-Empangeni line has been completed, and a Government survey of the Umhlatuzei River is being made in connection with the irrigation scheme of the Nkwaleni Valley where cotton, cane, tobacco, and citrus are being successfully grown.

337. TANGANYIKA. The *Rpt. of the Dept. of Agr.* for 1925-26, recently received, gives much useful information concerning cotton-growing in the territory under the following heads: Seed distribution to natives; ploughing; improvement of the quality of cotton; marketing improvement and extension; experimental work at the Agricultural Stations; statistics of crop production and exports; control of pests and diseases.

338. *Cotton Prospects.* (Abstr. from *Financ. Times*, May 16, 1927.) "The rains of March continued in April, and all food crops along the Central Railway are in good condition, and the cotton-planting around Morogoro and Kilosa is doing very well. In the earlier part of the year the cotton-planting around Shinyanga and Mwanza district suffered from drought, but second plantings have been made, and latest advices say that these crops are assured."

339. *Cotton Cultivation in Tanganyika.* (Abstr. from *East Afr.*, iii., **135**, 1927, p. 973.) The Commissioner, H.M. Eastern African Dependencies Trade and Information Office, has been advised telegraphically from Dar-es-Salaam that there have been good general rains in Tanganyika Territory, with renewed planting of cotton on the coast and along the Central Railway.

340. UGANDA. *Cotton in Uganda.* (Abstr. from *East Afr.*, iii., **133**, 1927, p. 903.) All things considered, the cotton crop is moving quite well, and in view of the reduction in export tax, rail and ocean freights, the grower is getting in some cases as high a price as he got last year. The weather during the past month has been

exceptionally good for the ripening of the crop, and the quality is well above that of any previous year. The quantity will be less than last year, but at this date it is difficult to say to what extent.

The railway extension reached Tororo at the end of January, and the first 500 bales of cotton have already been shipped direct to the coast. It is said that the line should be completed right through to Jinja by July.

341. AUSTRALIA. *Spinning Industry in Australia.* (Abstr. from *Text. Rec.*, xlv., **530**, 1927, p. 79.) Manufacturing developments of considerable magnitude are taking place in Australia, and although it will be some years before the spinners and manufacturers of this country feel the effect of severe competition, there is no doubt that, aided by tariffs and bounties, the textile plants will grow rapidly.

342. FIJI. *Cotton.* Council Paper No. 5, 1927, gives the history of the agitation raised on the subject of the supposed damage to Fijian cotton by the presence of traces of mineral oil. This has been shown to be incorrect, experiments proving that the staining of the cotton is due to the action of some insect, probably the so-called stainer-bug.

343. QUEENSLAND. *Callide Cotton Research Station, Biloela. Annual Report for the Year ending June* 30, 1926. By W. G. Wells. (*Queensland Agr. Jnl.*, xxvii., **3**, 1927, pp. 191-212.) With some exceptions, the cotton plots gave very good yields. Good progress has been made in the work of breeding cottons to suit local requirements. Many experiments of different kinds are described in detail. (*Cf.* "Reports received from Experiment Stations, 1925-26," published by the Empire Cotton Growing Corporation.)

344. *Cotton Ginning Agreement in Queensland.* (Abstr. from *Text. Rec.*, xliv., **529**, 1927, p. 111.) An agreement has been reached between the Queensland Cotton Board and the British Australian Cotton Association, Ltd., for the ginning of next season's cotton crop. The Association has agreed to gin, on behalf of the Board, the whole of the season's production at a charge of 1·125d. per lb. of lint. As a result of approaches made by the Board, the Queensland Government has undertaken to do the whole of the grading for the season without cost to the grower. The Association has also agreed to purchase the cotton-seed at the rate of £5 10s. per ton.

345. *Cotton Growing in Queensland.* (Abstr. from *The Queenslander*, March 26, 1927.) An account of a tour recently made by the Cotton Specialist through the cotton areas along the Gayndah line and then through the Upper Burnett. Mr. Wells states that a very gratifying interest in the general condition of the cotton industry was shown in all districts visited. This was in marked contrast with the ideas of many people not directly interested in the cotton industry, who seemed to think that it had failed. In reality it was on a better footing than it had ever been. In the early years of the present revival of cotton cultivation there was an appreciable migration of people from the cities to grow cotton, who in many cases paid exorbitant prices for land, under the impression that remarkable financial returns were to be received from cotton-growing. The men who were growing cotton today were, generally, much more experienced than were the majority of the growers during the first few seasons, and, as a rule, understood the general principles of cotton-growing to a much better degree. In nearly every district there were growers who had made profitable yields every season. These men were having a decidedly beneficial effect on their districts, and as their methods were more carefully followed the average yield per acre would show decided increases.

346. *The Cotton Board.* (Abstr. from the *Queensland Agr. Jnl.*, xxvii., **2**, 1927, p. 163.) The constitution of the Cotton Board has been altered to provide for

five representatives of growers instead of seven as originally provided. The members will now be elected biennially instead of annually.

347. WEST INDIES. *The Imperial College of Tropical Agriculture, Trinidad.* (Abstr. from the *West India Ctte. Circ.*, xlii., **743**, 1927, p. 101.) The British West Indian Colonies have been gratified to learn that His Majesty the King has consented to become Patron of the Imperial College of Tropical Agriculture in Trinidad, pursuant to the Royal Charter recently granted to that institution.

COTTON IN EGYPT.

348. EGYPTIAN COTTON NUMBER. (Pubd. by the *Man. Guard. Coml.*, March 17, 1927. Price 3d.) An extremely useful work upon Egyptian cotton. In the first article, entitled "Fine Cotton Growing in Egypt," the author, Victor M. Mosseri, points out that agriculture is the chief source of the country's wealth, accounting for about half the total income. He discusses the reasons which have made Egypt so important in agriculture, and goes on to discuss the deteriorations which usually occur in the different varieties of cotton grown. Finally, he describes the work that is being done to improve varieties.

Among the other interesting articles included in the supplement may be mentioned the following: "The Structure of Egyptian Cotton: Measurement of Spirals," by Dr. W. L. Balls, F.R.S.; "Problems of Water Supply in Egypt," by Sirry Bey; "The Rotation of Crops: Various Methods of Soil Conservation," by Galal Fahim Bey; "Vigorous Measures to Meet a Crisis," by H. M. Anthony; "Distribution of Cotton Seed: New Measures to Safeguard Quality," by H. E. Alphonse Greiss Bey; "Diseases and Pests of Cotton in Egypt," by C. B. Williams; "Cotton Ginning in Lower Egypt," by J. Barr; "High-Pressure Baling for Cotton," by A. Mills; "Marketing the Egyptian Crop," by A. W. Jessop and F. A. Tomlinson; "Financing the Cotton Crop," by H. S. Job; "World Demand for Long-Staple Cotton," by J. A. Todd.

The number is well furnished with illustrations and diagrams.

349. EGYPTIAN COTTON CROP. (Abstr. from *The Times*, April 11, 1927.) Current indications are that the 1926 cotton crop will be larger than had been expected hitherto. Arrivals to date at Alexandria since the beginning of the season have amounted to 7,250,000 kantars against 7,000,000 kantars in the same period last year.

This year there is a new factor calculated to encourage the retention of cotton in the up-country districts—namely, the Government scheme of advances to growers, and therefore it is permissible to expect that at least the same quantity has still to come down as at this date last year, when up to the end of the season a further 1,000,000 kantars reached Alexandria. As a matter of fact, the daily arrivals at Alexandria of both cotton and seed are much greater than in the same period of 1926, and there is justification in concluding that the 1926 crop will prove to be nearer 8,250,000 kantars than the hitherto authoritative estimate of 7,500,000 kantars.

350. COTTON PRODUCTION IN LOWER EGYPT. By R. H. Lucey. (*Agr. Coloniale*, xv., **104**, 1926. Abstr. from *Int. Rev. of the Sci. and Pract. of Agr.*, xviii., **1**, 1927, 26-T.) In 1926 the long-fibred varieties were mostly planted, such as Balls' Sakellarides 310, and Pilion. For the first time some forty large establishments received seeds of the Maarad variety. This is a splendid variety obtained after seven years' scientific selection by the technical experts of the Royal Egyptian Society of Agriculture, and was bred from 26 Pima capsules brought to Egypt in 1919 by Forbes and Freeman. It will most likely oust all the other long-fibred varieties produced by faulty selection during the last few years.

351. Revue Sommaire des Recents Travaux sur le Maintien et l'Amelioration de la qualité des Cotons Egyptiens. By V. M. Mosseri. (Pamphlet, 1927. Abstr. from *Summ. of Curr. Lit.*, vii., 8, 1927, E. 25.) A general discussion of the causes of the deterioration of Egyptian cotton, and a summary of the work of the Ministry of Agriculture, the Royal Society of Agriculture, the Administration of the State Domains, and the Cotton Research Board, on the maintenance and improvement of the quality. In his conclusion, the author emphasizes the need for isolating and purifying existing types or creating and propagating new and more advantageous types.

352. Nahda Cotton: Egypt. (Abstr. from *Egyptian Cotton Number* of the *Man. Guard. Coml.*, March, 1927, p. 5.) "The spinning results of this new variety have been very satisfactory, and we have every reason to believe that with a larger crop next year it will prove very popular with all users of medium-grade Sakel. Our own experience, so far, proves that it will and can displace present-day Sakels up to *Good*, for although the staple is not as long as the best Sakel, the regularity, fineness, and great lustre of Nahda are far superior to ordinary Sakel cotton as produced at present in Egypt. Spinners who have used Nahda have had only one complaint—that the price became prohibitive at one time during the present season when exporters were fighting one another to obtain supplies of this popular cotton. Both the counts produced and the small loss in spinning have proved the superiority of Nahda, and this variety has come to stay."

353. The Development of the Egyptian Cotton Plant. By M. A. Bailey and T. Trought. (*Bull. No.* 60 of the Tech. and Sci. Service, Min. of Agr., Egypt.) Evidence is produced to show that the normal period of development of a flower bud of cotton in Egypt is not less than forty-two days. Curves are included illustrating the rate of increase in width of buds during their development.

The normal period required for the completion of boll development in Egypt is shown to be about fifty-two days. Diseased bolls open after a shorter interval than healthy bolls, and the shortening of the period is roughly proportional to the severity of disease.

The average rate of elongation of an internode and its average extent of elongation fall steadily with each consecutive internode, whereas the period during which elongation takes place remains practically the same for all, with a slight suggestion of an increase in period in the more distant internodes.

The existence of regular flowering intervals in Egyptian cotton plants is demonstrated, and the intervals are shown to be of a similar order to those found by Harland in the case of Sea Island cotton.

The flowering curve for a single plant is shown to have a different form from that of the average curve, and to be rhythmic in character. The wave-length is about six and a half days, and is apparently identical in the two years 1923 and 1924. The origin of the regular periodicity of these curves is discussed. It is believed to be connected with the *average* flowering intervals of the plants, with a certain carry-over of flowers from one day to the next.

354. Egyptian Cotton Plant: Seasonal Chloride Content. By J. A. Harris. (*Chem. Abs.*, 1926, 20, 3308. Abstr. from *J. of Text. Inst.*, xviii., 2, 1927, A. 46.) In Egyptian cotton grown in the Gila River Valley in Southern Arizona, the chloride concentration of the plant increased with the advance of the season.

355. Rotation of Crops. (Abstr. from *Egyptian Gazette*, March 10, 1927.) Mr. A. M. Psalti, Cotton Inspector for the Dakahlia Province, in a recent lecture given at the Higher School of Agriculture, Giza, on the above subject, pointed out that the restriction law in Egypt is really an attempt to enforce rotation. He described the benefits of rotation, and suggested, as the amount of the "money" crop (cotton) was reduced, the trial of sisal-hemp or flax, fruit or tobacco.

COTTON IN THE UNITED STATES.

356. COTTON PRODUCTION: U.S.A. By G. W. Fooshe. (*Text. World*, 1927, **71.** Abstr. from *Summ. of Curr. Lit.*, vii., **5**, 1927, E. 9.) The author advocates increased yield per acre and an improved quality of product from a reduced acreage. An alternative means of decreasing the cost of cotton production lies in raising on the farms of the South all crops for domestic use, and regarding the cotton as a surplus crop. Increased yield from fewer acres also means a more adequate labour supply for harvesting, which in turn means prompter picking and conservation of the grade of the crop. Snapping and sledding involve irregularity of fibre and inclusion of foreign matter, and much waste.

357. SEA ISLAND COTTON: CULTIVATION. (*Cotton*, Manchester, 1927, **32**, No. 1566, 10. Abstr. from *Summ. of Curr. Lit.*, vii., **8**, 1927, E. 25.) The *New York Journal of Commerce* states that present low prices for short cotton and relatively high prices for long-staple cotton have aroused acute interest in the possibilities of restoring the Sea Island cotton industry in those sections of the South-Eastern States where it was formerly grown. According to specialists of the Department of Agriculture, however, improved methods of production and marketing would have to be established for a successful renewal. Efforts to resume production of Sea Island or of Meade cotton in the South-Eastern States would have to be organized for the exclusive production of one variety, and continued for several years to determine the advantages of isolated planting and improved cultural methods, to develop adequate stocks of pure seed, and to establish market relations for a high quality standardized product.

358. AMERICAN COTTON: TARES AND NET WEIGHT. (Abstr. from *Cotton*, March 12, 1927.) Washington advices state that a Bill proposing to standardize bales of American cotton at 500 lbs. net weight for interstate and foreign shipment has been introduced in the United States Senate. The Bill provides for the true net weight of lint cotton in the bale, exclusive of bagging and ties. The better taring of bales in the marketing of American cotton has been freely discussed on numerous occasions by leading Associations connected with the cotton trade, and the cheapness of cotton bagging this year has again stimulated interest to have a lighter and more serviceable covering of the bales, and the selling of cotton on a net-weight basis.

It is believed that by the standardization of American cotton bales there would result a very large saving in freight rates and insurance, for according to an estimate of the United States Bureau of Agricultural Economics the loss due to tare alone on a 12-million bale crop was around $150,000, and the loss on the present crop has already been estimated by the trade at the equivalent of more than half a million dollars.

359. COTTON-GROWING IN CALIFORNIA. (Abstr. from a report received from the Department of Overseas Trade.) Cotton has been commercially grown in California since 1909. At first short-staple varieties were cultivated, but gradually Acala has largely replaced them, and one-variety cropping is now being enforced. The San Joaquin valley is proving to be the best area for cotton, 114,000 acres out of a State total of 167,000 being located there in 1926. The average yield has been 313 lbs. an acre, as against 150 for the United States as a whole. Labour is mainly Mexican.

360. COTTON-GINNING HISTORY. By W. C. Saylor. (*Mech. Eng.*, 1926, **48.** Abstr. from *Summ. of Curr. Lit.*, vii., **5**, 1927, E. 13.) The circumstances of the invention of the cotton gin by Whitney (about 1797) are described, and its effects on the political affairs of the United States, by increasing cotton acreage in the South, and thus creating a greatly increased demand for slave labour, are traced.

361. CO-OPERATIVE COTTON VARIETY TESTS. By M. Nelson and J. L. Ware. (*Arkansas Sta. Bull.*, 210, 1926. Abstr. in *Exp. Sta. Rec.*, lv., **9**, 1926, p. 638.)

COTTON IN FOREIGN COUNTRIES.

362. We have received from the Association Cotonnière Coloniale a copy of Bulletin No. 78.

363. Cotton-Yield Trials in Algeria, 1924-25. (*Bull. de l'Office du Gouvernement général de l'Algérie* No. 7, 1926. Abstr. in *Int. Rev. of Sci. and Practice of Agr.*, xviii., **1**, 1927, 26-T.)

364. Cotton Culture in Argentina (trans. title). By C. D. Girola. (*Mus. Agr. Soc. Rural Argentina*, Pub. 49 (1926). Abstr. from *Exp. Sta. Rec.*, lv., **8**, 1926, p. 736.) Gives details of cotton-growing contests conducted in 1923-24 and 1924-25.

365. Cotton Cultivation in Argentina. (Abstr. from *S. Amer. Jnl.*, April 23, 1927.) The total area planted to cotton for the 1926-27 season is estimated as 71,746 hectares. This is equivalent to 65·2 per cent. of the area planted last year, but is 113·6 per cent. compared with the annual average for the five-year period 1921-22 to 1925-26.

366. The Possibilities of Brazil as a Competitor of the United States in Cotton-Growing. By B. Youngblood. (*Texas Sta. Bull.*, 315, 1926. Abstr. in *Exp. Sta. Rec.*, lvi., **2**, 1927, p. 183.)

367. Brazil. We have received from the Department of Overseas Trade a copy of the *Rpt. on the Econ. and Finan. Conditions in Brazil*, 1926, by Ernest Hambloch. *Cotton:* The official classification of cotton by officials of the Ministry of Agriculture has been instituted, and this measure should ensure improved and standard types for export. Cotton experimental and seed farms have been established in various states. The 1925-26 cotton crop is estimated at 148,000 tons against a yield of 172,000 tons in 1924-25.

368. Cotton Cultivation and Manufacture in Brazil. (*Text. Rec.*, xliv., **526**, 1927, p. 41.) The Brazilian cotton industry has been established on a systematic basis for nearly 150 years, and Brazilian cotton was first introduced into Lancashire in 1871. The quality of the cotton in the north, especially in the State of Rio Grande do Norte, is excellent, the staple being very long, but in São Paulo, where most of the cotton is grown, all the fibre is of short staple, 20 to 28 mm. In 1919 there were 220 factories, with a capacity of 50,449 looms; at the end of 1925 there were 257 mills, the number of looms and spindles operating in the country being estimated at 70,561 and 2,345,000 respectively. Brazilian materials do not as yet correspond to the style of goods most in demand, nor can the mills apparently turn out the superior classes of prints common to the Lancashire or American mills, which feed the textile trade of the whole of the world. Notwithstanding the progress made, therefore, there exists little chance of the country becoming independent of European manufacturers, as Brazilian cotton goods are mostly of low quality, for which there is purely a local demand.

369. China. *Cotton Cultivation in Jukao, Nantungchow and Haimen.* (Abstr. in *Text. Rec.*, xliv., **529**, 1927, p. 111.)

370. Cotton-Growing in Cilicia. By P. L. Vilmorin. (*Revue d'Histoire Naturelle appliquée*, v.-vi., **2**, 1925. Abstr. in the *Int. Rev. of the Sci. and Pract. of Agr.*, Rome. New Series, iv., **4**, 1926, p. 960.)

371. El porvenir del cultivo del Algodonero en la cuenca del Rio Paraguay. (The future of cotton cultivation in the valley of the River Paraguay.) By G. T. Bertoni. (Asuncion, 1923.)

372. Peru. We have received from the Department of Overseas Trade a copy of the *Rpt. on the Commercial, Economic, and Financial Conditions in Peru*, 1926, by J. P. Trant. *Cotton :* It is stated that half the food required is imported into Peru, while cotton fields extend to the very confines of Lima. The average cost of cotton production is said to be about 45 c. a pound, or above the actual selling price. More than £20,000,000 are now invested in cotton cultivation, which is employing over 40,000 hands. About 280,000 acres is the estimated area, all under irrigation, and the value of the export is about £6,000,000. Cotton pests and diseases are a serious menace, causing the loss of no less than 35 per cent. of the crop according to a recent estimate. An organized campaign is now under way to eradicate the pests. The principal variety of cotton grown is Tanguis, which constitutes about half the total amount of cotton cultivated in Peru.

373. Cotton in Portuguese East Africa. (Abstr. from *S.A. Cott. Growers' Jnl.*, iii., 7, 1927, p. 7.) With a view to fostering cotton-growing the Portuguese Government, in a recent decree, provides that the following, when destined for the cultivation and treatment of cotton, shall be exempt from import duties for a period of twenty years: Cotton seed, fertilizers, insecticides, agricultural implements, tractors and transport material; ginning and baling machinery; apparatus for disinfecting and sorting cotton seed, and machine parts for any of the above. The decree also levies a statistical tax of 0·1 per cent. *ad valorem* applied to all cotton exported from Portuguese territories during the next twenty years. Apart from this, no taxes or contributions are to be collected on exported cottons. To guard against the introduction of pests and diseases of the crop, importation of cotton-seed has been placed under special control.

374. Report on Cotton from Siam. By Sir George Watt. (*Tech. and Sci. Supplt. to "The Record."* Issued by the Ministry of Commerce and Communications, Bangkok, Siam, 1926.)

375. Cotton in Spain. A good deal of notice has lately been taken in the Press of the attempts to grow cotton in Southern Spain. Our own acquaintance is chiefly with the district about Rio Tinto, and in conversation with an important official there we were informed that the climate appeared to be too variable for rain-grown cotton, but that irrigation seemed to hold out prospects of success in such regions as the valley of the Guadalquivir. Spain imports some 100,000 bales, and it is hoped to be able to produce that amount.

376. Cotton Cultivation in Spain. Information received by the Department of Overseas Trade from the Commercial Secretary at Madrid is to the effect that cotton cultivation carried out in Andalusia during the past three years has yielded the following results: first year, 860,000 kgs.; second year, 1,097,000; and the third year, 5,364,000. The prices which have ruled during the past year were: ptas. 1.20 per kilogram for first-grade cotton, 1 pta. for second-grade, and pta. 0.80 for third-grade.

The foregoing results show the possibility of Spain intensifying her production of this raw material, and obtaining a great part of the fibre required for her textile industries, thus contributing to a favourable adjustment of the trade balance, in which the imports of cotton figure adversely to the extent of 300 millions of pesetas.

CULTIVATION AND MACHINERY ; IRRIGATION, ETC.

377. Essentials of Theory and Points of Practice in Crop-Weather Work. By F. L. Engledow. (*J. of the Min. of Agr., Great Britain*, November and December, 1926.) A paper read at the second conference arranged by the Ministry of Agriculture between workers engaged on the study of various aspects of the

effect of weather on crop growth, held at the Meteorological Office, London, on September 30 and October 1, 1926. The following is a brief summary of the paper.

The study of the effect of weather on crops represents an integration of almost all cropping problems, and is therefore a most complex and difficult task. The work involved is well worth while, however, if any definite relationships can be established—*e.g.*, the establishment of the relation between the weather and the growth of the wheat plant in the first six weeks of its life would represent a fundamental advance; and, in fact, the connection between any phase of weather and any phase of crop growth would be valuable.

In this work meteorologists have set the standards and the pace. Their work is done extremely well; they give to agriculturists definite accurate measurements of certain aspects of the weather every day, or even several times a day, right through the season. Agriculturists can, of course, measure yield with considerable statistical accuracy, but if no more than the yield is recorded the work is very incomplete. They should follow the meteorologists and give a series of numerical records from their plants right through the season.

Yield is most confusing; it is the final expression or resultant of growth. It can never be understood unless growth is understood. Agriculturists must contribute systematic observations on growth, and, as every day counts in the plant's life, the plant must be studied every day.

In addition to the weather, the soil and the farming procedure influence the plant, so that the study must be carried out on different soils and under different farming conditions. The present crop weather scheme provides for this and also for uniformity in crop observations. Difficulties met with in taking observations are apt to upset observers' schemes of recording, and consequently the greatest possible effort should be made to conform to specified procedure. The study should also pay the greatest attention to agricultural circumstances; the effect of weather on wheat following clover, for instance, may be different from that on wheat following fallow. Growth is never smooth; it proceeds, as it were, by jumps; constant attention is necessary to perceive and appreciate the importance of the various stages.

The following instances, in connection with investigations carried out on wheats show the importance of knowing all the factors influencing yield. Three varieties sown under similar conditions in 1924 and 1925 germinated in twenty-five days in 1924 and in fifty-eight days in 1925; delayed germination in the latter year was due to frost after sowing. In 1924, on three plots the number of plants surviving in an investigation was 180, 176, and 165; in 1925, the numbers were respectively 116, 114, and 84. In another case 88 per cent. of plants were attacked by wheat-bulb fly. Again, at Cambridge dry weather during the last week in April and the first week in May is common and hinders plant development; as a consequence the plant may be unable to take full advantage of succeeding spells of weather which, with a more suitable May, might have been very favourable to growth. In another year the weather may be favourable throughout. The agriculturist must obtain analytical data upon germination, the number surviving, the spacing of plants, critical periods, disease and pest damage, etc. The plants must be watched throughout life. It is also important to ascertain whether the general inferences from the observers' own plots or fields are supported by the evidence from fields in the neighbourhood; a practice should therefore be made of carefully studying the fields in the neighbourhood of the crop-weather station. Lastly, continuous observation of plots and fields will undoubtedly indicate plant characteristics and vital relationships that will prove very useful.

378. Ploughs and Ploughing. By E. A. Hardy. (*Saskatchewan Univ. Col. Agr. Exp. Bull.* **32,** 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **1,** 1927, p. 80.) Practical information on walking and riding ploughs, mouldboard and disc ploughs, plough adjustments and hitches, and methods of ploughing, is presented.

379. A Method of Yoking Two Pairs of Bullocks, Tandem. (Abstr. from the *Digest of Operations of the Dpt. of Agr., Madras*, December, 1926, p. 2.) At the cotton-breeding station at Coimbatore the following method of yoking two pairs of bullocks, tandem, has been in use for the last three years, and has been found to work satisfactorily. A pulley block is attached to the implement—usually a plough—one end of the chain is fastened to the yoke pole of the hind pair of bullocks; the chain is then passed over the wheel of the pulley and carried forward underneath the hind yoke to the yoke pole of the front pair. By this means the evil effects of irregularities of pull are eliminated, for if one pair pulls and the other does not, all that happens is that the slack of the chain is taken up until the non-pulling pair feels a backward draw to which it responds by pulling forward. As soon as both pairs are pulling, but not until, the implement moves forward. The risk of sore necks is minimized, and the chances of an animal straining itself by endeavouring to do something which is beyond its powers are eliminated. Instead of a driver to each pair of bullocks, a boy is all that is necessary. One pair cannot slack at the expense of the other, for if the front pair endeavour to do so the hind pair run into them from behind, and if the hind pair make the attempt the interval between the pair increases, and the driver applies the necessary correction. Once the animals have learnt what is required of them they settle down, one pair immediately behind the other, and maintain a steady pull until the end of the furrow is reached. As a precaution against the front pair getting too far ahead when turning at the headlands an iron pin is put through a link at a point in the part of the chain between the hind yoke and the pulley, such that when the animals are in position the pin is a few links ahead of the pulley.

380. The Effect of Spacing on the Yield of Cotton. By E. B. Reynolds. (*Texas Sta. Bull.* **340**, 1926. Abstr. in *Exp. Sta. Rec.*, lvi., **1**, 1927, p. 35.) Extensive spacing experiments with cotton conducted at the station and substations since 1914 are reported on, and the results of spacing investigations without the State are summarized. The references include 123 citations. The highest yields in general resulted from the close and medium spacing, 6 to 21 inches, in the different parts of the State, except in eastern Texas, where comparatively wide spacing, 27 to 36 inches, excelled. The cotton plant appears to be able to adjust itself to produce satisfactory yields within a comparatively wide range of spacing. Thinning cotton at the usual time generally produced larger yields than late or deferred thinning.

381. Cotton Spacing. By W. B. Rogers. (*Clemson Agr. Coll., S.C., Exp. Circ.* 78, 1926. Abstr. in *Exp. Sta. Rec.*, lvi., **1**, 1927, p. 36.)

382. Cotton Pickers in the United States. (Abstr. from *Int. Cott. Bull.*, vol. iii., No. 19, 1927, p. 373.) A description of the Berry Cotton Picker, which is stated to pick one acre of cotton an hour.

383. Une nouvelle machine pour recolter le coton. (Abstr. from *Bull. No.* 78. *Association Cotonnière Coloniale*, Paris, April, 1927.) A new cotton picker, invented by J. Brown Neill, which is said to give very satisfactory results, is being constructed at Rockhill in South Carolina.

384. "Cold Steam" Spraying Machines. By R. W. Leiby. (Abstr. from *J. of Econ. Ent.*, xx., **2**, 1927, p. 281.) *Field Crop Sprayer:* The steam machine has been adapted to the spraying of field crops, but has thus far only been used for the spraying of cotton. In this machine a 4 h.p. steam boiler is mounted on a two-wheel cart. Eight nozzles properly directed will envelop cotton 3 feet high in a mist of the spray. In an effort to control the boll weevil of cotton it was found that 5 lbs. of calcium arsenate could be suspended in as little as 5 gallons of

water, and the poison applied uniformly over an acre of cotton. Treating three rows at a time, an acre of cotton can be covered in fourteen minutes.

385. Cotton: Grading, Regain. By K. Pietsch. (*Leipziger Wochenschrift Text. Ind.*, **42**, 1927. Abstr. from *Summ. of Curr. Lit.*, vii., **7**, 1927, M. 7.) In consequence of complaints by suppliers of American cotton that the specifications of the Bremen Cotton Exchange for staple properties are too stringent, the author explains the requirements of cotton spinners as regards character, class, and staple length of the cotton they employ. It is alleged that American cottons contain at times more than 11 per cent. of conditioning moisture and frequently more than 8½ to 10 per cent., instead of agreeing with the permitted 8½ per cent. regain.

386. Snapped and Sledded Cotton. By F. G. Cobb. (*Text. World*, **71**, 1927. Abstr. from *Summ. of Curr. Lit.*, vii., Nos. 6 and 9, 1927, K. 45 and F. 12.) Bleachers and dyers are at present experiencing difficulty in obtaining bleached goods free from streaks and spots and even dyeings, and the trouble is attributed to the presence of snapped and sledded cotton.

Sledded cotton requires more beating to remove the trash, and its fibre is consequently weaker than the fibre of the same grade of cotton gathered in the regular way. A further danger is the inclusion in the stock of long, strong fibres of the inner layer of the bark of the cotton stalk. This cannot be removed by any of the preparing machinery, but goes through to the spinning frame where it will not draw, and causes ends down. Tests on sledded cotton have shown that 30 to 40 per cent. of the ends down were caused by this fibre. For this reason sledded cotton is worth less to a mill than picked cotton.

387. Round Bales. (Abstr. from *Text. Rec.*, xliv., **529**, 1927, p. 46.) It is said that vested interests apparently killed the round bale when it was first mooted some thirty-three years ago, but recently new developments have taken place. An article in the *Manufacturers' Record* states that two concerns in Texas have been making considerable progress in the establishment of round-bale presses. A new press has been developed capable of putting up a bale of an average size of 500 lbs. The round bales are covered with cotton cloth, and as the air is excluded in the process of making up they are practically non-inflammable.

(*Cf.* Abstract 219, vol. iii., p. 180.)

388. Annotated Bibliography on the Storage of Cotton-Seed and of Seed Cotton. By H. M. Steece. (*U.S. Dpt. Agr., Ext. Serv., Off. of Co-op. Ext. Work*, 1926.) This mimeographed bibliography presents in summary form the results of official and other investigations concerned with the storage of cotton-seed and seed cotton, and calls attention to bulletins and articles giving general information on the problem.

389. Cotton-Seed Products as Feed, Fertilizer, and Human Food. (*Texas Sta. Bull.* **341**, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **1**, 1927, pp. 22 and 68.) Discusses briefly the properties and composition of cotton-seed meal and hulls, with directions for feeding these products to the various classes of animals, and suggested rations for each; the relation of cotton-seed meal to diversified farming, and its use as a fertilizer; the use of cotton-seed flour as a human food.

390. Cotton-Seed Utilization, U.S.A. By D. Wesson. (*Oil and Fat Ind.*, **4**, 1927. Abstr. from *Summ. of Curr. Lit.*, vii., **6**, 1927, E. 24.) The economic independence of the cotton farmers of the South is believed to lie in efficient utilization of the seed. The treatment of seed for the preparation of oil and fodder is outlined, and the further treatment of cotton-seed oil for the production of edible oils and fats.

(*Cf.* Abstracts **318, 327, 353, 354, 355.**)

COTTON: DISEASES, PESTS, AND INJURIES.

391. The Application of Insecticides by Aeroplane. By Dudley Wright. In this paper, read before the Institution of Aeronautical Engineers on April 6, 1927, the author deals with the following: Various types of dust hoppers used; rate of dust delivery; atmospheric conditions; ground equipment and wind information; correct altitude for flight; effects of fog; method of treatment; quantity of poison required; grade of poison; alternative insecticides to calcium arsenate for leaf-worm control; danger of poison drift; types of aeroplane used in America; advantages over ground operations, and cost; possibilities in the British Empire.

392. A Chemical Investigation of some Standard Spray Mixtures. By R. E. Andrew and P. Garman. (*Connecticut Agr. Exp. Sta. Bull.* **278**, 1926. Abstr. in *Rev. Appl. Ent.*, xv., **4**, 1927, p. 194.)

393. Progress Report of Work of the Chemical Warfare Service on the Boll Weevil (*Anthonomus grandis*). By H. W. Walker and J. E. Mills. (Abstr. from *Exp. Sta. Rec.*, lvi., **2**, 1927, p. 158.) A report of preliminary tests made of some 1,000 poisons or poisonous mixtures, in which over 100,000 weevils were used. About fifty of the materials showed a toxicity equal to or greater than calcium arsenate, and of these over twenty showed little or no injury to the cotton plant. Barium, lead, zinc, mercury, and to a less extent iron, showed some measure of toxicity to the boll weevil when combined with other chemical groups in themselves harmless, and the toxicity of these metals seemed, in general, to be retained when combined with arsenic and to increase the toxicity of the resulting arsenical. Sodium fluosilicate, barium fluoride, and cryolite seemed to be equally as effective as calcium arsenate on a volume for volume basis. Every effort should be made to decrease the specific gravities of these compounds so as to give them the same covering power as the calcium arsenate. The authors believe that an advantage is gained in reducing the percentage of arsenic in calcium arsenate and using a larger amount per acre. It is pointed out that high concentrations of toxic gases are ineffective against the weevil, due to its apparent bility to suspend breathing more or less at will.

394. Winter Survival of the Cotton Boll Weevil at Florence, S.C. By F. A. Fenton and E. W. Dunnam. (Abstr. from *J. of Econ. Ent.*, xx., **2**, 1927, p. 327.) From 1922 to 1926 an average of 3·27 per cent. of cotton boll weevils survived the winter in various types of protective shelters at Florence, South Carolina. Practically all weevils issuing from hibernation before cotton was available as a food plant died, the average longevity at this time being 5·64 days. Of weevils emerging from winter quarters after cotton came up, and placed in field cages on young cotton plants, a great majority died before these started to square, their average longevity under these conditions being 8·12 days. Weevils emerging at or after the time when squares were developed on cotton plants were longer lived in these same field cages than those emerging prior to this time, the average longevity for males being 16·28 and for females 13·42 days. The maximum longevity at this time was sixty-six days for males and forty-six for females. According to trap crop records and field counts, weevils continued to enter the cotton fields for three to four weeks after the first squares formed, or until about the time the first blooms appeared.

395. Report (1925-26) of the Entomologist. By L. O. Howard. (*U.S. Dpt. Agr. Washington, D.C.*, 1926. Abstr. from *Rev. Appl. Ent.*, xv., **3**, 1927, p. 143.) To control the cotton boll weevil investigations on the attractive properties of certain

constituents of the cotton plant have been continued, and certain dilutions of trimethylamine and ammonia have proved attractive in laboratory tests; the value of these in practical field use is to be determined. While it is expected that several hundred thousand acres of cotton will be dusted by aeroplane, special attention has been given to the development of motor-operated high air velocity machines for ground dusting. The cotton-leaf perforator (*Bucculatrix thurberiella*, Busck) is doing increasing damage each year, and is now estimated to destroy from 15 to 30 per cent. of the crop.

396. NOTES ON A NEW FUNGUS OF THE BOLL WEEVIL. By J. Krafka and J. E. Miller. (*Ann. Ent. Soc. Amer.*, xix., 4, 1926. Abstr. *Rev. Appl. Ent.*, xv., 3, 1927, p. 137.) Resting sporangia of a fungus (*Pseudolpidium* sp. ?) of the family Chytridiales were found in the alimentary tract of a dead boll weevil (*Anthonomus grandis*, Boh.).

397. SENSES OF THE COTTON BOLL WEEVIL. AN ATTEMPT TO EXPLAIN HOW PLANTS ATTRACT INSECTS BY SMELL. By N. E. McIndoo. (Abstr. from the *J. of Agr. Res.*, Washington, D.C., vol. xxxiii., No. 12, 1926, p. 1095.) Since the sense of smell in boll weevils is believed to be the primary one which aids them in locating cotton plants, the two kinds of so-called olfactory organs have been thoroughly studied and described. The organs, called olfactory pores by the writer, are common to both the adult and larva; but the other so-called olfactory organs, which are nothing more than ordinary innervated hairs, are common only to the antennæ of the adult, although similar innervated hairs are also found on other parts of both adult and larva. In the adult the olfactory pores were found on the head capsule, legs, elytra, wings, mouth parts, and at the base of the antennæ; in the larva, on the head capsule, base of antennæ, mouth parts, clypeus, and second thoracic segment. The individual and sexual variations found in the pores of each of five males and five females were small, although the females have 13·7 per cent. more pores than have the males. The anatomy of these pores is like that described for many other beetles by the writer, except that some of them are slip-shaped, closely resembling those in spiders. These are found on the maxillary papillæ of both adult and larva and on the legs of the adult.

The antennæ of boll weevils have four types of sense organs, as follows: Many innervated hairs, chiefly on the club; three or four olfactory pores at the base of each antenna; and two so-called auditory organs in the second segment. Not one of these organs, except the olfactory pores, is suited anatomically to receive olfactory stimuli. The hairs are all long and thick-walled throughout their full length, and consequently odours cannot pass through them. The so-called auditory organs are totally internal, having no outside connections whatever, so that they certainly cannot receive olfactory stimuli.

Innervated hairs were found widely distributed over the surface of the boll weevil, being present on the head capsule, antennæ, mouth parts, thorax, legs, wings, abdomen, and genitalia. According to their structure, they seem to be fitted only for tactile organs, and, judging from their number and distribution, the sense of touch must be highly developed. When the insect is once upon its proper food and ready to deposit eggs, the tactile sense may be more important than the olfactory sense. The numerous sensitive hairs on the antennæ, mouth parts, ovipositor, penis, and elsewhere must certainly render great aid in the various activities of the boll weevil.

No organs were found which can really be called taste organs, although some of the smaller innervated hairs on the mouth parts of both adult and larva would be designated taste organs by certain writers. The present writer believes that the senses of smell and taste in insects are inseparable, but since insects in many cases must first "taste" certain foods before they can discriminate between them, this combined sense may be comparable to ours when we smell flavours.

Three so-called auditory organs were found: two in the pedicel, or second antennal segment, and one in the base of each wing. We know nothing about the function of these organs, and, indeed, it is difficult to imagine what their offices might be, unless they receive some kind of waves which we cannot detect, such as some of the inaudible sound waves, or even radio waves; but the writer has been informed that radio waves cannot be considered in this connection.

Judging from the structure of the compound eyes, the visual field of the boll weevil is small and its image of objects is neither sharp nor distinct, indicating that it cannot by sight alone distinguish from a distance cotton plants from certain other plants, or in all probability even the various parts of a cotton plant when it is near them.

As a corollary to the sense organs, the scent-producing organs, sometimes called scent glands or recognition glands, were also studied. These are minute unicellular, hypodermal glands, and are widely distributed over the surface of the insect. Their secretion comes to the surface, spreads out over the integument, and, besides keeping the body moist, is also supposed to give off an odour which probably serves as a recognition odour among the beetles themselves.

It will have been noted that the olfactory sense has been greatly emphasized, perhaps too much, but in the present state of our knowledge there seems to be no other tangible sense or senses which serve quite so well to explain how boll weevils find cotton plants from a distance. When they have once found their food or a place to deposit eggs, we can easily think of two or more senses being employed in their activities thereafter, touch, smell, and "taste" particularly being used during feeding and egg-laying, as has recently been pointed out by Richardson, who reviewed the literature pertaining to the oviposition response of insects.

398. Report (1925-26) of the Federal Horticultural Board. By C. L. Marlatt. (*U.S. Dpt. of Agr., Washington, D.C.*, 1926. Abstr. from *Rev. Appl. Ent.*, xv., 4, 1927, p. 193.) The status of the control of the Pink Bollworm is summarized, and a map is given showing areas infested in Texas and New Mexico in 1925. The problem of the Thurberia Weevil is also discussed. It can maintain itself on cotton without the necessity of renewal each year from *Thurberia*, and can hibernate in the cotton with very little mortality.

399. Protecting Cotton from Injury by the Bollworm. By D. Isely. (*Univ. Arkansas Coll. Agr. Extens. Circ.* 218, 1926. Abstr. from *Rev. Appl. Ent.*, xv., 2, 1927, p. 91.) The Cotton Bollworm (*Heliothis obsoleta*, F.) is a serious pest of cotton in Arkansas, but seldom causes widespread injury in the same district in successive years. In midsummer the life-cycle occupies thirty-five to forty days, and there are three or four generations a year. Many of the overwintering pupæ in the ground may be destroyed by ploughing. The most effective means of protecting cotton is to use late maize that comes into silk about two weeks after the main crop of maize has hardened. If June maize is not planted, it is advisable to plant a trap-crop, five to ten rows being sufficient to attract the moths from a field of cotton 300 feet wide. The trap-crop should be planted on two dates so that it comes into silk two or four weeks after the main crop of maize hardens. Though it will not entirely protect the cotton, it will greatly reduce the damage. Maize should not be planted amongst cotton, as it serves as a source of infestation in the field. Dusting with calcium arsenate at the rate of 5 to 7 lbs. to the acre will kill newly hatched larvæ, but can only be recommended as an emergency measure.

400. A Note on the Cotton Bollworms of South Africa. By J. S. Taylor. (*Ent. Rec. and Jl. Var.*, xxxviii., 11, 1926. Abstr. from *Rev. Appl. Ent.*, xv., 3, 1927, p. 154.) The most important of the bollworms attacking cotton in South Africa is *Diparopsis castanea*, Hamps. (Sudan or Red Bollworm), which occurs in

all stages throughout the season, having four or five generations a year. Attacked bolls rarely mature, and if they are not completely hollowed out by the larvæ they may ripen prematurely, in which case they are dwarfed and stunted, or they may be destroyed by boll rot. Cotton is the only crop attacked by *D. castanea,* which is confined to Africa; it has been found breeding on a few wild species of Malvaceæ. Next in importance is *Heliothis* (*Chloridea*) *obsoleta,* F. (American bollworm), which attacks the squares, flowers, bolls, and even leaves of cotton; infestations by this species are sudden and frequently severe. The spiny bollworms, *Earias insulana,* Boisd., and *E. biplaga,* Wlk., attack the squares, flowers, and bolls of cotton and various wild Malvaceæ, but do not usually cause serious damage in South Africa, although in 1926 fairly heavy infestations occurred. Both species have several generations a year, and the larvæ pupate in cocoons attached to the food-plant or on the surface of the soil; hibernation occurs in the pupal stage, as with the two preceding species.

401. NOTES ON THE PINK BOLLWORM. By F. H. S. Warneford. (Printed at the Government Printing Office, Antigua, Leeward Islands, 1926.)

402. COTTON PESTS IN BURMA. By T. D. Stock. (*Rpt. Dpt. Agr., Burma,* 1925-26. Abstr. from *Rev. Appl. Ent.,* xv., 4, 1927, p. 199.) More than nine alternative food-plants have been found for the spotted bollworms, *Earias fabia,* Stoll, and *E. insulana,* Boisd., of which cotton is the most attractive, particularly the varieties with succulent bolls. These two insects breed throughout the year, and their life-cycles occupy about four weeks. Five parasites, which include *Bracon* (*Microbracon*) *lefroyi,* D. and G., *Rhogas estaceus,* Grav., and *Actia ægyptia,* Vill., although present throughout the season, did not control them. Fallen buds and mature bolls, but not the dry fruits, harbour a large number of these bollworms, and as both mature and dry bolls harbour numerous individuals of *Platyedra gossypiella,* Saund. (Pink Bollworm), the effective disposal of any bolls left on the plants after harvest is important. The latter insect has not been observed on any plant but cotton.

403. THE COTTON FLEA. In the January issue of this journal (Abstract 81, p. 79) Professor Cox is quoted as saying that "the cotton flea is probably the same as the Jassid of South Africa." We are indebted to an entomologist on the staff of the Corporation for pointing out that "the cotton flea is a Capsid belonging to a different division of Hemiptera from the Jassid of South Africa, and except that both are bugs there is no resemblance in structure or habits."

404. COTTON FLEA IN THE SOUTH. By C. A. Whittle. (*Manfrs. Rec.,* 90, 1926. Abstr. from *Exp. Sta. Rec.,* lvi., 1, 1927, p. 60.) The cotton flea is said to have appeared in 1926 in damaging numbers over a wider territory than ever before known. This was due, it is thought, to climatic conditions that favoured a large survival over the winter, and to the presence of early host plants in great profusion, such as evening primrose, croton, and horsemint, on which plants the insects feed and breed in late winter and early spring. It is pointed out that, when some of these early host plants matured and died down, their flea population migrated to the cotton plants and there resumed feeding and breeding.

405. THE COTTON HOPPER (*Psallus seriatus,* Reut.). By C. Lyle. (*Qtrly. Bull. State Plant Bd. Mississippi,* vi., 2, 1926. Abstr. from *Rev. Appl. Ent.,* xv., 2, 1927, p. 73.) The Cotton Hopper, *Psallus seriatus,* Reut., and the damage that it does to cotton are briefly described. This Capsid was first found on cotton in Mississippi in 1925, but it did little damage in that year; in 1926 it occurred throughout the northern part of the state, where it caused considerable injury. In June and early July it was much more abundant on croton and horsemint (*Monarda*) than on cotton, but cotton was heavily infested during most of July;

by August 20 the Capsids had almost entirely deserted the cotton, but were present in large numbers on croton. Dusting with 10 lbs. superfine sulphur to the acre, making two or more applications at intervals of four days, is recommended as a control measure; cotton treated in this way after considerable injury had already taken place was found, two weeks after the second application, to have 60 per cent. more squares and 33 per cent. more bolls to each stalk than cotton in adjacent plots that were not dusted. If the boll weevil (*Anthonomus grandis*, Boh.) is also causing damage, a dust of two parts superfine sulphur and one part calcium arsenate, 12 lbs. to the acre, can be used to control both pests.

406. Cotton Jassids in French Sudan. By J. Vuillet. (Abstr. in *Agr. J. of India*, xxii., **11**, 1927, p. 147.)

407. Cotton Jassid in South Africa. By J. L. Moerdyk. (Abstr. from *Trop. Agriculture*, iv., **3** and **4**, 1927.) An account of investigations carried out: (1) To determine whether the Jassid is the responsible agent for the cotton-plant disease attributed to it; (2) to see how the deterioration of the plant is brought about; (3) to find the cause of the resistance of some strains to the disease and the susceptibility of others; (4) to study the habits of the Jassid.

408. The Tarnished Plant-Bug on Cotton. By C. Lyle. (*Qtrly. Bull. State Plant Bd. Mississippi*, vi., **2**, 1926. Abstr. from *Rev. Appl. Ent.*, xv., **2**, 1927, p. 74.) During 1926 cotton in parts of Mississippi was attacked by *Lygus pratensis*, L. (tarnished plant-bug), which caused an injury almost indistinguishable from that caused by *Psallus seriatus*, Rout.; it is probable that both Capsids transmit a virus that is the direct cause of the injury, more especially as *L. pratensis* causes injuries of a similar or related nature to many plants. In controlling this pest on cotton, good results were obtained by two or three applications of superfine sulphur at the rate of 10 lbs. to the acre.

409. Cotton Pests—I. By L. A. de Azevedo Marques. (*Bol. Minis. Agr. Ind. e Comm.*, xv., (ii.), **3**, 1926. Abstr. from *Rev. Appl. Ent.*, xv., **2**, 1927, p. 68.) Cotton plants in the Brazilian State of S. Paulo are attacked by the larva of a weevil, *Gasterocercodes gossypii*, Pierce, which mines the roots and stem.

410. Cicadas Injure Cotton. (*Qtrly. Bull. State Plant Bd. Miss.*, vi., **2**, 1926. Abstr. from *Rev. Appl. Ent.*, xv., **2**, 1927, p. 74.) *Tibicen vitripennis*, Say, caused serious injury to cotton in June in a field in Northern Mississippi; the females split the stalks and smaller branches during oviposition, destroying many of them. About 90 per cent. of the plants were injured, and one-quarter of the stand was destroyed.

411. India: New Insect Pests discovered during the Year 1926. (Abstr. from *Int. Rev. of the Sci. and Pract. of Agr.*, Rome, xviii., No. 2, 1927, p. 116-T.) *Coleoptera:* Elaterid grubs were discovered attacking the roots of young cotton plants at Poona.

412. Studies on Indian Thysanoptera. By H. H. Karny. (*Mem. Dpt. Agr. India*, Ent. Ser., ix., **6**, 1926. Abstr. from *Rev. Appl. Ent.*, xv., **2**, 1927, p. 101.) A complete list of the known Thysanoptera of South India. The new species include *Anaphothrips oligochætus* in flowers and shoots of cotton.

413. Fighting Locusts with a Contact Insecticide. By C. H. Gable. (*J. Econ. Ent.*, Geneva, N.Y., xix., **6**, 1926. Abstr. from *Rev. Appl. Ent.*, xv., **2**, 1927, p. 86.) During the latter part of June, 1925, an outbreak of *Schistocerca obscura*, F., was reported from Texas. The chief damage was done to cotton. As a rule the locusts congregate on the tops of trees and brush on the edge of the field, and only enter the latter in numbers for feeding purposes. The adults

were successfully destroyed on the trees by spraying with a standard cattle dip at the rate of 1 part to 80 of water. The dip used had the following analysis: Total arsenic water-soluble as metallic 15·14 per cent., actual arsenious oxide (As_2O_3) 20·02 per cent., water 44·40 per cent., equal parts of soft soap and sodium cresolate 20·44 per cent. The spray cannot be used on cultivated crops without causing serious injury. All the plants sprayed were severely scorched, but though they were well covered with the spray they produced no ill-effect when given to cattle as food.

414. Locusta (Pachytylus) migratoria, L., and L. danica, L., as Independent Forms, and their Derivatives. By V. I. Plotnikov. (In Russian. Abstr. in *Rev. Appl. Ent.*, xv., **4**, 1927, p. 162.)

415. Attacking the Tsetse Problem in Northern Nigeria. (Abstr. from *East Afr.*, iii., **133**, 1927, p. 890.) It is suggested as a means of control of the tsetse fly that no effort should be made to preserve the antelope in Northern Nigeria, as this animal and the pig form the only important sources from which the fly derives the virus that destroys domestic stock. The effects of sweeping grass fires and of cutting down parts of the forest are also being investigated as control measures.

416. Sulphuric Acid Treatment of Cotton Seed. By R. G. Archibald, (*Soil Science*, xxiii., **1**, 1927.) In recent years the sulphuric acid treatment of cotton seed has been advocated as a preventive measure for certain diseases attacking cotton, notably the bacterial disease known as Angular Leaf Spot, Black Arm, or Boll Rot, and the fungal disease known as Anthracnose.

The results obtained by the American workers Rolfs, Faulwetter, Ludwig, and others justified an experimental trial being carried out on a small scale in the Sudan, more especially in relation to the control of Black Arm disease of cotton.

An initial series of experiments was carried out to note the effect of acid treatment on the germination of the seed. The acid treatment of seed, whether concentrated or in dilutions of $\frac{1}{20}$, $\frac{1}{100}$, $\frac{1}{200}$, $\frac{1}{500}$ for periods longer than one hour, affected adversely the germination of the seed. In periods of treatment less than, and up to, one hour seedlings usually appeared above the soil in five days.

Comparative field observations were carried out on a large scale with seed treated in the proportion of 500 gms. of seed to 100 c.c. concentrated sulphuric acid for fifteen minutes to half an hour, washed, dried, and sown two months later, and with seed untreated and sown under the same conditions. The treated seed showed better germination than the untreated, and resulted in a healthier plant with better vegetative growth. Data regarding the final yield of cotton are being collected.

Sulphuric Acid Treatment as a Preventive Measure for Black Arm.—It may be stated at the outset that sulphuric acid treatment of Black Arm infected cotton seed has not given the results claimed by American workers. Preliminary pot experiments were carried out; cotton seed from an infected source being treated with sulphuric acid and sown under conditions which excluded the possibility of infection from soil, water, or insects. Seed treated with concentrated sulphuric acid for one hour and five minutes yielded, in one experiment among others, 5 per cent. of seedlings with typical angular leaf-spot infection of the cotyledons.

Investigations by the writer have shown that the causal organism of Black Arm can be recovered and grown from the tissues internal to the seed coat; short of destroying the germination of the seed, it is difficult to conceive of acid treatment affecting the vitality of bacilli within the resin canals and tissues of the embryo. Organisms lying immediately below the seed coat could certainly be adversely affected by acid treatment. It would appear, then, that at the most a partial sterilisation of the seed can result from sulphuric acid treatment. Field

observations by the writer show that there can be no doubt, however, that acid treatment exerts a beneficial effect, by delaying the manifestations of Black Arm disease and so permitting the plant to obtain a good stand before infection is apparent. More information, however, is required regarding the predisposing factors concerned with the spread of the disease. Environment, climate, soil, and farming methods appear to play a major or minor part, and are being investigated.

417. PRELIMINARY NOTE ON AN INTERNAL BOLL DISEASE OF COTTON IN BURMA. By D. Rhind. (Abstr. from *Agr. Jnl. of India*, xxii., **1**, 1927, p. 34.) Deals with an internal disease of unripe cotton bolls caused by two species of *Nematospora*, chiefly, if not entirely, inoculated by the bug *Dysdercus cingulatus*. The most serious disease of cotton in Burma.

418. BLACK ARM DISEASE OF COTTON, WITH SPECIAL REFERENCE TO THE EXISTENCE OF THE CAUSAL ORGANISM B. MALVACEARUM WITHIN THE SEED. By R. G. Archibald. (Abstr. from *Soil Science*, xxiii., **1**, 1927, p. 5.) The conclusions arrived at by the author are as follows:

1. Investigations have shown that, in Black Arm disease of cotton, the causal organism can be recovered from the tissues within the seed coat.
2. A technique is described for recovering the bacillus from the seed tissues.
3. The feeble resisting powers of the organism toward such adverse conditions as strong sunlight, desiccation, and high temperature render it unlikely that the outer coat of the seed, with its lint and fuzz, harbours infection.
4. The bacillus can be recovered from apparently healthy tissues below Black Arm lesions.
5. The seed appears to be the main source of infection.
6. The causal organism has not been found in soil or water, and the epidemiology of the disease does not favour the hypothesis that the disease is insect borne.
7. No hosts other than the cotton plant have been found.
8. Seed sterilisation by means of concentrated sulphuric acid has yielded disappointing results. A more effectual way of attacking the problem is to ascertain the factors that predispose to manifestations of infection, and to raise a healthy type of plant capable of resisting as well as of throwing off infection when attacked.

419. A NEW HOST FOR BACTERIUM MALVACEARUM. By J. G. Brown and F. Gibson. (*Phytopathology*, xiii., 1923, No. 10. Abstr. from *Exp. Sta. Rec.*, **54**, 1926, p. 649.) As a result of inoculation experiments the authors have established the parasitism of *B. malvacearum*, the cause of angular-leaf spot on Arizona wild cotton (*Thurberia thespesioides*).

420. FUNGOID DISEASES OF COTTON IN SOUTHERN NIGERIA. By T. Laycock. (Abstr. from *Fifth. Ann. Bull. of Dpt. of Agr.*, Nigeria, 1926, p. 17.) The conclusions arrived at by the author are as follows:

1. American cotton shows considerable immunity to fungoid pests, excepting those which gain entrance through injuries to the boll due to insects.
2. Of the insect-borne fungi which affect both American and native cotton bolls, *Nematospora*, the specific fungus of the Internal Boll Disease, is by far the most important.
3. Bacterial diseases due to *Pseudomonas malvacearum* (E.F.S.) are not important on the American variety, but during wet seasons might cause considerable damage to the indigenous varieties. Their control by seed disinfection is advocated because, in addition to the damage resulting from them, there are the boll-rotting potentialities of the saprophyte *Fusarium*, which is invariably found associated with the bacterium.

4. More data are required before we can fully understand the fluctuating incidence of Anthracnose boll-rot disease, although it does appear to be correlated with severe harmattan conditions and high boll-worm incidence.

5. The importance of control measures with regard to insect pests cannot be over-emphasised. Needle inoculations with six different fungi have resulted in boll rots, and, as the contents of developing cotton bolls are comparable with nutrient broth cultures, it will be easily understood that even saprophytes, gaining access to the interior of the boll through insect lesions, may find the conditions very suitable for their further development, and produce boll rots.

421. Ozonium Root Rot. By G. L. Peltier *et al.* (*U.S. Dpt. Agr. Bull.* 1417, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **2**, 1927, p. 145.) The results of a study of the root rot of cotton, alfalfa, and other plants in the south-western portion of the United States.

422. Cotton Diseases in the West Indies. (Abstr. from *Trop. Agriculture*, iv., **5**, 1927, p. 88.) Dr. Briton-Jones states that two root-rotting diseases of adult cotton plants, previously unrecorded in the West Indies, have recently been found to affect several varieties at the Research Station in Trinidad. The imperfect stages of the two fungi causing these diseases both belong to the genus *Rhizoctonia.* One of the diseases, which is popularly known as Root-Rot, is caused by the fungus *Rhizoctonia bataticola* (Taub), Butler. This has been previously observed causing a wilting of adult cotton in India and Egypt. It is found on several other host plants in different parts of the world.

The second disease is also found on several host plants other than cotton, in Europe and the United States. It is generally known as Violet Root-Rot, and is caused by *Rhizoctonia crocorum*, Pers. (D.C.). Duggar states that no well-authenticated instance of the occurrence of this disease in South America, Australia, Asia, or Africa has come to his attention. So far as is known the fungus has not been previously recorded on the cotton plant elsewhere.

423. Report of the Plant Pathologist, Florida, 1925. By O. F. Burger. (*Flor. Sta. Rpt.*, 1925. Abstr. from *Exp. Sta. Rec.*, lv., **9**, 1926, pp. 841-2.) *Cotton Diseases:* Cotton disease investigations organized under the charge of A. F. Camp included studies on variety resistance to cotton wilt, seedling diseases, the delinting of cotton seed as a measure for the control of seed-borne diseases, angular leafspot, anthracnose, etc. A number of varieties of cotton were found to exhibit marked resistance to wilt, and reciprocal crosses were made of some of these. The F_1 generation was grown to produce material for testing on wilt-infested soil. Delinting seed with sulphuric acid was found of advantage not only in the reduction of disease, but it made possible the planting of seed by a plate planter rather than by an ordinary planter. In dry soil this proved important, as the seed was covered by a layer of moist soil and germination hastened.

424. Cotton Wilt in Central Provinces and Berar. By D. V. Bal. (*J. Ind. Bot. Soc.*, v., **3**, 1926. Abstr. from *Rev. Appl. Mycol.*, vi., **4**, 1927, p. 226.) In this paper the author presents certain data in criticism of Dastur's theory that wilt disease of cotton in the Central Provinces, India (attributed by him in collaboration with Ajrekar to a species of Fusarium) is primarily due to the accumulation of aluminium salts in the plant tissues. Samples of soils from normal and diseased areas were found to be quite alkaline, with pH values of 8·0 to 8·6 and 8·4 to 8·8 respectively. Water extracts from such soils did not contain even traces of soluble aluminium, while determinations of active aluminium in the soils themselves showed the proportion to be very small. Pot-culture experiments carried out in the Central Provinces many years ago proved that superphosphate did not reduce wilt disease, although if the latter were due to aluminium concentration

the addition of superphosphate would be expected to check it. The author also draws attention to the lack of analytical data on the aluminium content of healthy and wilted plants and of information concerning the effect of water extracts from wilt-producing soils on the plant. Finally, he points out that even if an excess of aluminium salts occurs in wilted plants, this may simply be due to the disturbance of the physiological processes caused by the fungus.

425. Efforts to Determine the Means by which the Cotton-Wilt Fungus (*Fusarium vasinfectum*), Induces Wilting. By H. R. Rosen. (Abstr. from the *J. of Agr. Res., Washington, D.C.*, vol. xxxiii., No. 12, 1926, p. 1143.) A large number of experiments are recorded in which pure cultures of different strains of the cotton-wilt fungus were grown on various liquid media, the fungus removed from these, and toxicity studies undertaken with the filtrates.

It is shown that filtrates representing cultures growing on Richards' solution are quite toxic to cotton plants, while filtrates of cultures growing on media containing organic nitrogen such as Uschinsky's asparagine solution or peptone-beef broth are non-toxic. May not this explain why cotton wilt is much more prevalent in light sandy soils devoid of appreciable quantities of organic nitrogen as compared with richer types of soils? Attention is called to the difference in metabolic products to be expected in media of diverse composition.

When cultures are filtered through fine filter paper the filtrate is found to contain viable spores. It has been determined that while the sterile Richards' solution is markedly acid, testing pH 4·0 to pH 4·4, the growth of the cotton-wilt fungus for two to three weeks renders the solution considerably less acid, the hydrogen-ion concentration ranging from pH 6·0 to pH 6·6. It appears, however, that this change in acidity is not the factor which renders the filtrates toxic.

When whole plants with root systems carefully handled are placed in filtrates of *Fusarium vasinfectum*, wilting ensues as with plants that are freed from roots.

That the toxic properties of filtrates of Richards' solution are not due to increases in osmotic pressure was determined by diluting the filtrates and observing the action of the solution on cotton plants.

Substituting glucose for sucrose in Richards' solution, it is found that the fungus makes as good a growth as in the sucrose medium, and that the glucose medium also possesses toxic properties. It was found that uninoculated glucose Richards' solution caused a slight withering of the leaves.

In very bright sunlight it is recorded that filtrates cause wilting much more rapidly than in diffused light.

By subjecting filtrates to distillation *in vacuo* as well as to ordinary boiling and testing, the distillates as well as the residues were found to possess toxic properties, the residue being considerably more toxic. The distillates possess a pungent odour and give an alkaline reaction. Tests for amines and alkaloids in the distillates were negative.

The filtrates of two or three weeks old cultures on Richards' solution gave positive tests for nitrites. These were found in quantities ranging from 0·0125 to 0·04 mgm. of nitrogen for each cubic centimetre of solution. Using chemically pure sodium nitrite solution comparable to the concentration found in the filtrates, it was determined that this is markedly toxic to cotton plants.

Comparing the action of filtrates of three different species of Fusarium on cotton plants, it was found that a filtrate of *F. tracheiphilum*, the cowpea-wilt fungus, is comparable in toxicity to filtrates of *F. vasinfectum*, while a filtrate of *F. lycopersici*, the tomato-wilt fungus, is considerably less toxic. Attention is called to the close relationship existing between the two first-mentioned species.

Attempts to obtain calcium salts of any organic acid present in the filtrate of the cotton-wilt fungus resulted in failure.

Microscopic observations of the vascular elements of wilted cotton plants

clearly indicate that wilting is not due to a mechanical plugging up of the vessels by the fungus.

It is recorded that wilted cotton plants are occasionally found in fields badly infested with the wilt-inducing fungus from which the fungus is apparently absent. It is suggested that the wilting and interior discoloration of the xylem in these cases is due to the formation of toxic substances by the fungus in the soil.

The conclusion is drawn that filtrates of *Fusarium vasinfectum* growing on Richards's solution possess at least two substances poisonous to cotton. One is a volatile compound with an alkaline reaction and the other is an inorganic salt in the form of nitrite.

The wilting of cotton infected with *Fusarium vasinfectum* is considered to be due to poisonous chemical substances formed by the fungus.

426. Weather Damage to Cotton. By R. L. Nixon. (*U.S. Dpt. Agr. Bull.* 1438, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **1**, 1927, p. 36.) Bales of cotton were fully protected in the warehouse, while others were variously exposed to the weather, in tests at five representative points in the Cotton Belt. Unprotected bales placed with their flat surfaces next the ground without turning averaged a loss of 54·7 per cent. of their original gross weight; bales on poles and protected by canvas lost 2 per cent.; and bales placed on poles and turned once a week, or at least after each rain, lost an average of 3·9 per cent. All of the tests showed a direct relationship between the amount of moisture absorbed and the resulting damage. Since the fungi responsible for discoloration and decay of the fibres thrive best under temperate conditions, the cotton damaged much faster during spring and summer months. Baled cotton should evidently be placed in a properly constructed warehouse under responsible management as soon after ginning as possible. If warehousing is impracticable, the bales should be stored in a dry place out of the weather, or, as a last resort, they should be edged up on poles and turned at least weekly.

427. We have recently received from the Department of Mycology, Rothamsted Experimental Station, Harpenden, Herts, copies of the following reprints:

1. *Recent Work on Virus Diseases in Plants.* By J. Henderson Smith. (From the *Proc. of Roy. Soc. of Medicine*, vol. xx., 1927, pp. 11-18.)
2. *Biochemical Decomposition of Cellulosic Materials, with Special Reference to the Action of Fungi.* By R. D. Rege. (From *Annals of Appl. Biology*, vol. xiv., **1**, 1927.)
3. *A Method of Isolating and Handling Individual Spores and Bacteria.* By S. Dickinson. (From the *Proc. of Roy. Soc. of Medicine*, vol. xix., 1926, pp. 1-4.)

BREEDING, GENERAL BOTANY, ETC.

428. Heritability of Different Rates of Shedding in Cotton. By T. H. Kearney and R. H. Peebles. (*J. of Agr. Res., U.S.*, xxxiii., **7**, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **2**, 1927, p. 128.) An interspecific cotton hybrid, Pima Egyptian × Acala, was studied to ascertain whether genetic factors are involved in the shedding of the flower buds and the young bolls (abscission before and after anthesis). Practically no difference was observed in the mean percentage of bud shedding, whereas boll shedding was at a much higher rate in Acala than in Pima. In both the F_1 and F_2 generations the hybrid gave much lower mean percentages of bud shedding than either parental population, while the mean percentage of boll shedding by both hybrid generations was between the parental types. The mean shedding percentage both of buds and bolls was about twice as great in F_2 as in F_1, and the differences were very significant. Eliminating the soil variation did not void this difference. While the frequency distributions of

the F_1 population for percentage of bud shedding and percentage of boll shedding gave no indication of segregation in definite ratios, the behaviour may be interpreted on the theory that three or more genetic factors are involved. The much greater variation in F_2 than in F_1 suggested that Mendelian segregation occurred. Further evidence of genetic factors in shedding was shown by the significant differences obtained by comparing the shedding percentages of pairs of adjacent F_2 plants, which practically eliminated the influence of soil heterogeneity, and also by the great disparity between the sizes of observed and expected standard deviations of the hybrid. This investigation is held to have supplied evidence that there are genetic factors for shedding which segregate and recombine in the usual manner.

429. BRANCHED COTTON HAIRS: OCCURRENCE. By N. W. Barritt. (*Nature*, 1927, **119**. Abstr. from *Summ. of Curr. Lit.*, vii., **6**, 1927, A. 13.) Two photographs are reproduced of a branched hair found in a sample of Sakellarides cotton of good quality. Further examination of the sample revealed the existence of "lateral protuberances," one of which is shown in a third photograph.

430. SOILS: MOISTURE-ABSORBING CAPACITY. By J. N. Son and B. M. Amin. (*Mem. Dpt. Agr. India*, Chem. Ser., **8**, 1926. Abstr. from *Summ. of Curr. Lit.*, vii., **6**, 1927, A. 15.) A study is described of the relation between the clay content and the absorptive capacity of soils and of the influence of temperature on the moisture absorption.

431. BACTERIOLOGICAL METHODS FOR THE INVESTIGATION OF SOIL FERTILITY. By H. R. Christensen and H. L. Jensen. (*Int. Rev. of the Sci. and Pract. of Agr.*, New Series, iv., No. 4, 1926, p. 775.)

432. GERMINATING FATTY SEEDS: PHYSIOLOGY; AND COTTON SEED HYPOCOTYL: RESPIRATORY QUOTIENT. By J. B. Rhine. (*Bot. Gaz.*, **82**, 1926. Abstr. in *J. of Text. Inst.*, xviii., **2**, 1927, A. 47.)

433. THE EFFECT OF TEMPERATURE ON THE DEVELOPMENT OF THE COTTON PLANT. (In Russian.) By G. S. Zaitzev. (No. 7 of the *Trans. of the Turkestan Plant-Breeding Station, Tashkent.*) The conclusions, given in English, state that the influences of temperature tell upon all the phases of development of the cotton plant, such as germination, appearance of the first leaf, first buds, blooming, and dehiscence of the bolls, and also upon all the insignificant intermediate phases which determine the alternation of leaves, buds, flowers, and opened bolls. In most cases the correlation between temperature and duration of both insignificant and important phases is almost complete, approaching to 1, and is always inverse—*i.e.*, the lower the temperature the longer the phases, and the higher the temperature the shorter the phases.

The correlation between temperature and length of phases is not rectilinear but curvilinear; the dependence between the length of a phase (of short succession) and the temperature may be expressed by the following formula: $n = 26{\cdot}25 - 1{\cdot}685 + 0{\cdot}0303t^2$; where n is the number of days, t the temperature in degrees of Celsius. As a general rule we may consider that at temperatures lower than 20° C. the cotton plant experiences a "warmth-shortage," and above 20° C. a "warmth-saturation"; finally, at 28° C. (or possibly somewhat higher) the cotton plant reaches the limit of warmth-saturation; above this the temperature gives surplus warmth, which is not accompanied by corresponding accelerations of plant development. The mean optimal temperature is probably approaching 25° C.

Asiatic cotton is somewhat less affected by low temperature than American, and the early-maturing varieties of the latter less than the late.

In conclusion, the author emphasizes the importance, from the cultivable point of view, of the fact that the rate of development of the cotton plant is definitely

a function of temperature. The usual method of assessing the possibilities of growing cotton in a given region often takes account only of summer temperatures. This method may lead to erroneous conclusions, and the author makes out a strong case for the computation of "isophases" by getting accurate temperature and growth records throughout the life-history of the plant.

434. Estimation of Plant-Sap Chloride. By J. V. Lawrence and J. A. Harris. (Abstr. from *Agr. J. of India*, xxii., **11**, 1927, p. 144.) For use in ecological studies of the variation in plant tissue fluids with environment, the Volhard method is employed for determining the chloride content of plant saps. The method is applicable to freshly collected and preserved fluids and is well adapted for use in field work.

435. Variability in the Ginning Percentages in Crosses of Indian Cottons. By R. Prasada. (Abstr. from *Agr. Jnl. of India*, xxii., **1**, 1927, p. 23.) With a view to evolving a variety of cotton possessing a fairly long staple and high ginning percentage, and capable of fitting into the climatic conditions of the United Provinces, numerous crosses were made between the various types of cotton at the Botanical Research Farm, Cawnpore. The present article describes the variations in ginning percentages which were observed and recorded in the course of investigations carried out over a number of years on crosses made between *Gossypium arboreum* and *Gossypium neglectum roseum* cottons.

436. The Mixing of Cotton Varieties. By A. Howard and S. C. Talesara. (Abstr. from *Agr. Jnl. of India*, xxii., **1**, 1927, p. 61.) Experiments in feeding bulls with uncrushed cotton seed showed that a number passed through in a viable condition, and the need to crush or boil all seed is emphasized.

(*Cf.* Abstracts 313, 352.)

CO-OPERATION.

437. Co-operation: Its Principles and Forms. By Anna Ornsholt. (*J. of the Bd. of Agr., British Guiana*, xx., **1**, 1927. pp. 18-29.)

LEGISLATION.

438. India. *Notification No.* 154 of January 26, 1927, is a further amendment of Notification No. 1561-Agri. of November 26, 1925, amending clause (*c*) of paragraph 2 of Notification No. 1493-Agri. dated November 11, 1925.

439. Nigeria. *Regulations* (No. 37 of November 29, 1926) deal with the power of entry of officers of the Agricultural Department into cotton ginneries or stores for purposes of inspection, cotton markets and cotton grades, compulsory grading in certain provinces, prohibition of mixing grades, marking bales, and distribution of cotton seed.

Regulations (No. 47 of December 28, 1926) deal with the importation of cotton seed, cultivation of American cotton, uprooting and burning of cotton plants, and control measures against insect pests.

440. South Africa. *Regulations* (No. 2174 of November 27, 1926) deal with the export of cotton lint and seed cotton oversea.

441. Australia. *The Cotton Bounty Act* (No. 51 of August 23, 1926) provides for the payment of a bounty on the production of seed cotton and cotton yarn for a period of five years commencing on August 16, 1926. The rate of bounty payable for the higher grades of seed cotton is 1½d. per pound, and for the lower grades ¾d. per pound. The rates of bounty payable on cotton yarn vary from ½d. per pound for count No. 1 to 12d. per pound for count No. 41 or any higher count.

The total amount of bounty authorized to be paid in any one financial year shall not exceed the sum of £120,000 for seed cotton, and £60,000 for cotton yarn, or a total expenditure over five years of £900,000.

442. *Statutory Rules* (No. 151 of October 27, 1926) deal with the procedure to be followed in claiming the cotton-yarn bounty, and provide for the inspection of process of manufacture and of accounts.

443. QUEENSLAND. *The Cotton Industry Acts Amendment Act* of October 16, 1926, amends sections 3, 23, and 38 of the Principal Act, and inserts after section 13 the following: Section 13*a*, dealing with the power to acquire cotton seed; 13*b*, pure seed districts; 13*c*, test plots.

444. THE TEXAS COTTON SEED REGISTRATION AND CERTIFICATION ACT. By E. P. Humbert *et al.* (*Tex. Dpt. Agr. Bull.* 80, 1925. Abstr. from *Exp. Sta. Rec.*, lv., **8**, 1926, p. 736.) The text of the law is given, with regulations and instructions relative to its enforcement.

CHEMISTRY AND PHYSICS IN THEIR APPLICATION TO COTTON PROBLEMS.

445. AMIDATED COTTON. (Abstr. from *Text. Rec.*, xlv., **530**, 1927, p. 60.) Karrer and Wehrli observe in the *Zeitschrift angew. Chemie* that in the process of the immunization of cotton, only the surface layers of the individual fibre are esterified, the inner portions still being composed of unaltered cellulose. The same applies also to amidated cotton. The affinity of direct and basic dyestuffs for amidated cotton, and the fastness properties of the dyeings, vary with the degree of amidation of immunized cotton. If the ester group is removed, for instance, by boiling with a concentrated solution of potassium cyanide, the immunity towards direct dyestuffs is destroyed. Moreover, acetylation of the amido group, by boiling with acetic anhydride for one hour, diminishes the affinity for acid dyestuffs considerably. At the same time, the immunity to direct dyestuffs, which is somewhat lost by prolonged treatment with ammonia, is restored. During acetylation amidated cotton is converted into an acetylated amino-cellulose, and its immunity to direct dyestuffs is comparable to that of cellulose acetate. There is as yet no definite knowledge of the chemical constitution of amidated cotton.

446. COTTON: ACTION OF LIGHT. (*Melliand's Textilber.*, **7**, 1926. Abstr. from *J. of Text. Inst.*, xviii., **2**, 1927, A. 72.) A short discussion on Kauffman's paper. In reply to a question whether dyeing might actually increase the injurious effect of light on cotton, as in the dyeing of curtains with iron buff, it is stated that experiments had been made with a number of metals, including iron, and no difference had been found.

447. COTTON: MEASURABLE CHARACTERS. By J. Leluc. (*Avenir Text.*, **9**, 1927. Abstr. from *J. of Text. Inst.*, xviii., 4, 1927, A. 113.) The author discusses the necessity for standards for the measurable characters, and for spinning tests of (French) colonial cottons, and adds a note on ginning.

448. COTTON PLANT MINERAL CONSTITUENTS: OCCURRENCE. By J. S. McHargue. (*Chem. Abstr.*, **21**, 1927, 791. Abstr. from *Summ. of Curr. Lit.*, vii., **8**, 1927, B. 36.) A total of 185 lbs. of copper, iron, manganese, zinc, calcium, magnesium, phosphorus, potassium, sodium, sulphur, and nitrogen were present in each acre of crop. Nitrogen, calcium, and potassium occur in the largest quantities and in nearly equal proportions. Sulphur, phosphorus, and magnesium occur in considerably smaller proportions. More sodium occurs than either phosphorus or

magnesium; 0·4 lb. of copper, 0·1 lb. of manganese, and 0·16 lb. of zinc per acre are probably vitally concerned in the production of a crop of cotton.

449. IMMATURE COTTON: DYEING. (*Melliand's Textilber.*, **7**, 1926. Abstr. in *J. of Text. Inst.*, xviii., **2**, 1927, A. 65.)

450. THE INFLUENCE OF HUMIDITY ON THE ELASTIC PROPERTIES OF COTTON. III. ON THE BREAKING LOAD AT 20° C. By J. C. Mann. (Vol. vi., 1927, of the *Shirley Inst. Memoirs.*)

451. COTTON YARN: IRON CONTENT. By P. Krais. (*Leipziger Monats. Text.-Ind.*, **42**, 1927. Abstr. in *Summ. of Curr. Lit.*, vii., **4**, 1927, B. 18.)

452. COTTON: MEASURABLE CHARACTERS; SPINNING QUALITY. (*Leipziger Monats. Text.-Ind.*, **42**, 1927, 150. Abstr. from *Summ. of Curr. Lit.*, vii., **8**, 1927, G. 26.) A table is given showing to what counts it is practicable to spin different varieties of cotton, and indicating whether combing is necessary in addition to carding. Warp and weft counts are differentiated. The cottons include Sea Island, American, Egyptian, Brazilian, Peruvian, Indian, and Chinese varieties, and the data given include staple length and average hair diameter.

453. SHORT-STAPLE COTTON: SPINNING. By J. J. Rieter and Co., A.-G. (*Ind. Text. J.*, **37**, 1926. Abstr. from *J. of Text. Inst.*, xviii., **4**, 1927, A. 121.) A special form of revolving flat carding engine, to which a web divider is joined, is used in conjunction with a special ring spinning frame in order to spin coarse counts up to 18's of lower qualities of Indian cotton. The yarn thus obtained is more even than the one produced with passages on drawing and roving frames, and its strength is the same. The carding engine and ring spinning frame and their methods of use are described.

454. COTTON: SPINNING QUALITY. By O. Johannsen. (*Leipziger Monats. Text.-Ind.*, **42**, 1927. Abstr. from *Summ. of Curr. Lit.*, vii., **8**, 1927, G. 26.) The author shows that erroneous results may be obtained in judging the spinning value of a cotton on staple length and strength alone. In an example, an 18's single yarn was spun from a cotton variety P which gave a better staple diagram and a stronger staple than a second cotton variety A, which was spun into a similar 18's yarn. The yarn spun from P possessed higher breaking strength and extensibility than the yarn from A, but when twisted into a 15-fold yarn (5/3) gave a lower breaking strength test than a corresponding 15-fold yarn spun from A. Assuming that the strength of a fibre structure depends on the friction between individual fibres and on the specific strength of the material, and that the frictional strength is the more effective the greater the surface of friction, the density of the hairs in the two twist yarns was examined. The twist of P variety cotton was found to have a lower number of hairs per cross-section than the twist from A variety, and it is concluded that the decrease of friction surface on account of the stronger and coarser hair is the cause of the surprising inferiority of the P variety. The deduction is drawn that it is safe to assume that a higher individual hair strength will give a better yarn only when comparing hairs of equal fineness.

455. OIL-SPRAYED COTTON YARN: SCOURING. By A. H. Grimshaw. (*Amer. Dyestuff Rep.*, **15**, 1926. Abstr. from *Summ. of Curr. Lit.*, xviii., **4**, 1927, A. 130.) Comparative tests on the scouring, bleaching, and dyeing properties of yarns sprayed with a straight mineral oil, a 50 per cent. sulphonated oil, and two emulsifiable mineral oils, are described. Extraction tests showed that the sulphonated oil possibly left less extract than did the other oils. Dyeing and bleaching tests showed that cotton sprayed with emulsifiable oil will give as uniform results in dyeing and bleaching as can be obtained by using sulphonated oils.

456. THE COMPOSITION OF CRUDE COTTON-SEED OIL: A SUMMARY. By G. S. Jamieson and W. F. Baughman. (*J. Oil and Fat Indus.*, iii., **10**, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **2**, 1927, p. 108.) A summary of data reported in the literature on the physical and chemical constants and chemical composition of crude cotton-seed oil.

457. THE EFFECT OF DESIGN AND COLOUR ON THE PRODUCTION OF COTTON GOODS FOR THE DIFFERENT MARKETS OF THE WORLD. (Abstr. from *J. of Text. Inst.*, xviii., **3**, 1927, P. 73.) A paper read by Mr. A. E. G. Brookes before the Manchester Athenæum Textile Society in February, 1927. In speaking of the Overseas trade in fancy goods, Mr. Brookes pointed out the necessity of this receiving greater care and attention in the future. The previously held belief that native customers had no taste for colour or design was no longer tenable, and taste abroad was now on a par with that of this country. Turning to the Home markets, the importance was stressed of exploring every avenue to find new uses for cotton fabrics. Mr. Brookes asserted that Lancashire was pre-eminent as a manufacturer of plain cloths and in the preparation of new styles, but in order to hold this position "more men were needed with imagination and enterprise, who were not afraid to attack new problems and who could suggest new ideas." Such men should be adequately trained so that they may grasp every opportunity; they should realize that the future must lie with those fabrics which depend for their value on beauty of design, colour effects, and finish.

458. SPECIAL TREATMENT OF COTTON. By A. J. Hall. (Abstr. from *Man. Guar. Coml.*, April 7, 1927, p. 401.) Some interesting facts concerning the dyeing and finishing of cotton materials were revealed in a paper read by Mr. A. J. Hall to the Nottingham Section of the Society of Dyers and Colourists on "Some Special Treatments of Cotton," particular reference being made to the effect on cotton of concentrated acids and alkalis.

Nearly twenty years ago the late Professor Knecht drew attention to the peculiar action of nitric acid on cotton, but, strangely enough, no mention was made of the effect which has recently received technical application. When cotton is treated with cold nitric acid of sp. gr. 1·41 it shrinks about 10 per cent., increases in weight, and becomes stronger because of the partial nitration which occurs, and gains a fourfold increased affinity for direct and other dyes. Such effects are also accompanied by a striking change in handle, the treated cotton being much warmer to the touch and acquiring wool-like properties. Schwartz has developed the process (German Pat. 389,517), and, as worked by the Philana A.G. in Basle, it is able to give to cotton fabrics a soft, warmer handle. Numerous dyes and printed samples of philanized cotton fabrics were shown, and their superior handle and appearance were in striking contrast to the original untreated cotton fabric.

Cotton gains considerably in strength during philanization, the tensile strength being increased about 50 per cent., and the bursting strength about 250 per cent. Philanized cotton contains no oxycellulose and only traces of cellulose nitrates. Although concentrated nitric acid is difficult to handle in ordinary bleaching and dyeing works, such difficulties are by no means insuperable. There are distinct commercial possibilities in the production of special finishes on cotton goods by treatment with nitric acid.

459. THE SWELLING OF COTTON FIBRES. By A. J. Hall. (*Text. Colorist*, **48**, 1926. Abstr. in *Exp. Sta. Rec.*, lvi., **3**, 1927, p. 297.)

460. TRANSPARENT FINISH ON COTTON FABRIC. (Abstr. in *Text. Rec.*, xlv., **530**, 1927, p. 60.) Describes the process invented by Heberlein and Co. of Switzerland (German Pat. 433,180).

461. COTTON MILL: POWER LOSSES. By G. Wrigley. (*Mech. Eng.*, **48**, 1926. Abstr. from *J. of Text. Inst.*, xviii., **2**, 1927, A. 73.) A general discussion. It is stated that, except for possible small savings in conductor and shafting losses, no immediate betterment of transmission appears probable. Large savings, if any, must come in the textile machines, possibly by better and closer adaptation of electric power to the actual work, or by other changes in design.

462. COLLECTING THE LITERATURE OF TEXTILES. By C. F. Goldthwait. (*Amer. Dyestuff Rptr.*, **15**, 1926. Abstr. from *Exp. Sta. Rec.*, lvi.. **3**, 1927, p. 297.) The filing system outlined has been applied to almost the whole textile field from raw materials to clothing, including textile chemistry.

MISCELLANEOUS.

463. BRITISH COTTON GROWING ASSOCIATION. The 22nd Annual Report contains much of interest. Details are given of the work in the various portions of the Empire. The Khanewal farm in the Punjab in 1925-26 showed a yield of 15·9 maunds* per acre on a total area sown of 2,424 acres; this is the highest yield yet attained, and is at least 30 per cent. above that of any other estate in the Punjab. The work here is setting a good example, which is now being followed by the surrounding cultivators.

The decreasing demand for lace is causing depression in the Sea Island cotton trade of the West Indies. In Nigeria, American seed has not proved satisfactory, but it is hoped that the Ishan type will be successful. Stress is laid on the need for improved transport in Africa, and an account is given of the steps that are being taken to provide it. The report ends with tables of statistics of production, imports into the United Kingdom, exports from Colonies, etc.

464. THE TEXTILE INSTITUTE, MANCHESTER. An interesting article in the May issue of the *Textile Recorder* states that steady progress is being maintained in the work of the Textile Institute, and the many and varied activities of that body are being excellently organized into a very forcible factor for textile technological advancement.

465. THE ROMANCE OF THE COTTON INDUSTRY IN ENGLAND. By L. S. Wood and A. Wilmore. (Pubd. Oxford Univ. Press, price 5s. net.) An account of the gradual growth of the cotton industry in England from its earliest beginnings through the period of the domestic system, the period of the great inventions of Kay, Arkwright, Crompton, and others, the period of improvement of transport and communications, and the industrial revolution.

Incidentally, in referring to cotton pests, the authors confuse (*e.g.*, p. 258) the boll *weevil* with the boll *worm*. The former insect is found only in the United States, but the latter (of which there are several varieties) causes damage to cotton in most of the cotton-growing countries.

On p. 256 the authors state that Uganda sends much of her raw cotton to India, but it should also be pointed out that most of it is re-exported.

466. THE COTTON YEAR BOOK, 1927. (Abstr. in *J. of Text. Inst.*, xviii., **4**, 1927, p. 104.)

467. COTTON PRODUCTION AND DISTRIBUTION FOR SEASON 1925-26. (Bull. 160 of *Dpt. of Com., Bureau of Census, Washington, D.C.* Abstr. in *Int. Cott. Bull.*, v., **3**, No. 19, 1927, p. 499.)

468. COTTON. (*Bur. Ry. Econ., Washington, D.C. Commodity Prices, etc., Bull.* 13, 1926. Abstr. from *Exp. Sta. Rec.*, lv., **8**, 1926, p. 785.) This bulletin is one of a series of studies on commodity prices in their relation to transportation costs, and deals primarily with the relation of the prices of the 1925-26 cotton crop

* 1 maund = 82$\frac{2}{7}$ lbs.

and freight rates to representative consuming mill centres, the principal ports of export, and other destinations. Comparative prices of cotton for 1923-24, 1924-25, and 1925-26, and statistical data and charts of production, distribution, and consumption of cotton in the United States and foreign countries over a period of years are included. The present study indicates (1) that there are marked fluctuations in prices paid producers from week to week, month to month, and season to season; (2) that such fluctuations are not uniform in the same general territory, are in excess of the freight rates to even the more distant consuming centres, and are not caused by freight rates; and (3) that the freight rates, even on long-distance hauls, are only a small proportion of the price of cotton, and do not retard the freedom of movement of the cotton.

469. COTTON PRICES AND MARKETS. By A. B. Cox. (*U.S. Dpt. Agr. Bull.* 1444, 1926. Pubd. by Govt. Printing Office, Washington, D.C., price 15 cents a copy.) A most useful compilation. The question of Demand, and the factors that determine it, is first gone into, and is followed by that of Supply (including all the various countries contributing thereto). The various questions connected with prices and markets are then dealt with, and the terms "Futures," "Straddle," "Basis," and "Squeeze" are explained.

470. COTTON PRICE FORECASTING. By P. Wallis. (Abstr. from *J. of Text. Inst.*, xviii., **3**, 1927, p. 45.) In a paper read at a meeting of the Lancashire Section of the Textile Institute, the author makes use of the following formula in describing a method of forecasting cotton prices: "Growers of cotton, if they are to continue to be growers of cotton, will require each year per acre a cash return adjusted for changes in the purchasing power of money. Therefore, each year the yield per acre in lbs. of cotton multiplied by the price per lb. must produce such a cash return. This sum of money represents the cost of production of cotton and will vary if any variation takes place in the cost of producing gold." The working of the theory in past years is shown by examples, and for the present season the author forecasts a price of 14 dollars 50 cents on a crop estimated at 17½ million bales.

471. 1926 SALES EXCEED PRODUCTION. (Abstr. from *Text. Rec.*, xliv., **528**, 1927, 99.) Reports just completed by the Association of Cotton Textile Merchants of New York show for the first time the results of a full year's operations in the cotton textile industry. This data covers production, sales, shipments, and stocks of a large number of standard cotton cloths for the year 1926. The reports indicate: first, that an unusually large volume of cotton goods were consumed last year; second, that sales for the year exceeded production; and third, a large reduction in the amount of goods on hand. During the year sales of standard cotton textiles included in the Association's statistics exceeded production for the year by 2·9 per cent. Stocks on hand at the mills on January 1, 1927, were 9 per cent. less than stocks on hand on January 1 a year ago. Unfilled orders on January 1 this year were 20 per cent. greater than unfilled orders on the same date a year ago.

472. THE COMPARATIVE POSITION OF THE LANCASHIRE COTTON INDUSTRY AND TRADE. By Professor G. W. Daniels and J. Jewkes. (Abstr. in *Int. Cott. Bull.*, v., **3**, No. 19, 1927, p. 499.)

473. COTTON: VALUING. By T. Bühler. (*Leipziger Monats. Text.-Ind.*, **42**, 1927. Abstr. from *Summ. of Curr. Lit.*, vii., **4**, 1927, L. 9.) Continuing previous work on the accurate evaluation of cottons, the author deduces a formula by which the value of a cotton can be obtained from measurements of staple, purity (percentage of good fibre), colour, and tensile strength. These factors are defined and determined for twelve typical cottons, and the method of calculation shown.

474. COTTON AND ITS IMPORTANCE TO THE MOTOR INDUSTRY. By A. M. Munro. (Abstr. from the *Australian Motorist*, March 1, 1927.) An interesting article dealing with the important part cotton plays in the manufacture of motor tyres.

475. "SONA," A NEW FABRIC. By W. Whittam. (*Text. Rec.*, xliv., **529**, 1927, p. 90.) A new textile material, the development of which, it is stated, will provide a new and extensive use for cotton in America.

476. NEW USES FOR COTTON. (Abstr. from *Text. Rec.*, xliv., **529**, 1927, p. 108.) The United States Civil Service Commission is to hold an examination for a specialist who will devote his time to investigating new uses for cotton. The duties outlined by the Commission are to plan, conduct, and direct investigations of factors affecting the utilization of American cotton; compile and co-ordinate information relative to the uses of such cotton, and opportunities for increasing its scope and usefulness, and prepare this information for dissemination through publications and other channels. The starting salary will be 3,800 dollars a year.

477. COTTON: SETBACK FROM LOW PRICES. By J. A. Todd. (*Times Trade and Eng. Supplt.*, May 21, 1927, p. 6.)

478. CARTELS AND COMBINES. By Professor H. Clay. (*J. of Text. Inst.*, xviii., **4**, 1927, p. 77.)

479. LIST OF BULLETINS OF THE AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES FROM THEIR ESTABLISHMENT TO THE END OF 1920. (*U.S. Dpt. of Agr. Bull. No.* 1199, 1924.) A useful compilation of the titles of 12,500 publications of the State Experiment Stations from 1875 to 1920 inclusive.

480. SAMUEL CROMPTON: THE INVENTOR OF THE SPINNING MULE. A BRIEF SURVEY OF HIS LIFE AND WORK, WITH WHICH IS INCORPORATED A SHORT HISTORY OF MESSRS. DOBSON AND BARLOW, LTD. By Dobson and Barlow, Ltd., Bolton. (*J. of Text. Inst.*, xviii., **4**, 1927, p. 103.)

481. CHEMISTRY FOR AGRICULTURAL STUDENTS. By R. H. Adie. (Published by the University Tutorial Press, Ltd., London.)

482. THE AMBASSADOR OF COMMERCE, published as a supplement to the *Liverpool Daily Post*, February 21, 1927, gives a general description of Liverpool and its various activities and industries.

ADDENDUM TO COTTON IN INDIA.

INDIAN COTTON CULTURE: PROMISING OUTLOOK.

The Times, May 28, 1927.

The annual report of the Indian Central Cotton Committee shows that, whatever conclusions the Royal Commission on Agriculture may formulate in regard to the most suitable form of organization for developing agriculture, the system of bringing together all interests concerned, together with the improvement of the single crop, has yielded successful practical results.

The report produces evidence that recent legislation designed to improve the quality and reputation of Indian cotton and to discourage malpractices was timely and well conceived. Investigations into the finance of the cotton crop up-country point to the conclusion that what the cotton-grower now needs is better market facilities and a voice in the management of the primary markets where the produce is sold, and market rules enabling him to meet the buyer on an equal footing. Hence the way is clear for the establishment of open cotton markets foreshadowed in the Bill which the Government of Bombay recently published.

Dealing with research work, the report demonstrates how plant breeding is bringing further improved types of cotton into being. The investigations promise the evolution of better methods of cultivation, and are helping to accelerate the coming of the day when the yield of cotton per acre in India will compare less unfavourably with that elsewhere. The committees of the Technological Laboratory of Bombay have been chiefly engaged in testing the spinning capacity of cotton and the characters of the fibre. The facilities afforded in this report have been much appreciated. The committee is carrying out the policy of creating a body of qualified Indian investigators to deal with cotton problems.

PERSONAL NOTES

OFFICERS ON LEAVE.

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes "home" on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would call at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite to the offices of the Crown Agents for the Colonies.

At the date of writing the following officers are on leave in England from cotton-growing countries:

Gold Coast	Mr. W. C. Fishlock.
,, ,,	Mr. C. H. Knowles.
Kenya Colony	Mr. N. D. Spranger.
Nigeria	Mr. A. J. Findlay.
,,	Mr. A. G. G. Hill.
,,	Mr. P. H. Lamb.
,,	Mr. G. W. Lines.
,,	Mr. H. Roebuck.
,,	Mr. R. B. Shorter.
Sudan	Mr. R. Hewison.
,,	Mr. R. E. Massey.
Tanganyika Territory	Mr. D. G. Burns.
,, ,,	Mr. C. K. Latham.
,, ,,	Mr. J. F. C. O'Brien.
,, ,,	Mr. A. H. Ritchie.
,, ,,	Mr. A. J. Wakefield.
Uganda	Mr. G. F. Clay.
,,	Mr. A. B. Killick.

The following officers of the Corporation's staff abroad are also on leave in this country:

Mr. S. Milligan	South Africa.
Mr. G. Browne	Nigeria.
Mr. W. L. Miller	Nyasaland.

PRINTED IN GREAT BRITAIN BY
BILLING AND SONS, LTD., GUILDFORD AND ESHER

THE EMPIRE COTTON GROWING REVIEW

VOL. IV. OCTOBER, 1927. NO. 4

RECENT DEVELOPMENTS IN MECHANICAL TRANSPORT SUITABLE FOR USE IN TROPICAL DEPENDENCIES*

BY

MR. G. H. BAILLIE, MR. R. H. BRACKENBURY,

AND

COLONEL C. N. FRENCH.

IN March, 1924, the Executive Committee of the Corporation, realizing that there were large areas in Tropical Africa excluded from cotton-growing by lack of transport, appointed a Sub-Committee to investigate and report on the best and cheapest form of mechanical transport (other than railways) for carrying cotton and its rotational crops. Since that time, the Sub-Committee have been engaged in collecting information about local conditions, fuels other than petrol, and different types of vehicles and their effect upon roads, and have run some new types of vehicles in England and Nigeria to ascertain their possibilities.

The following paper, which was presented in the form of a memorandum to the recent Colonial Conference, embodies the results of the Sub-Committee's work and their conclusions under the following heads:

(*a*) The present position of transport in Tropical Africa and the need for its development.

(*b*) The Sub-Committee's tests and their conclusions.

(*c*) Recommendations for the development of transport and for future investigation and experiment.

(*d*) Suggestions for continuing the work initiated by the Sub-Committee.

(*e*) The problem of Cotton Transport.

(*f*) The Committee's conclusions on roads in Tropical Africa.

(*g*) Performance in soft sand of high and low pressure tyres.

(*h*) Suction gas producers.

* Reproduced from the Appendices to the Summary of Proceedings of the Colonial Office Conference, 1927, by permission of the Controller of His Majesty's Stationery Office.

(a) The Present Position of Transport in Tropical Africa and the Need for its Development.

(1) The problem of cotton transport is dealt with fully in (e). Areas that are available and suitable for cotton-growing are at present inaccessible for lack of transport. Moreover, as cotton should preferably be grown in rotation with other crops of low price, transport must be available for all kinds of agricultural commodities, and therefore cheap. The problem of cotton transport is, in fact, the problem of African transport generally.

(2) A railway is the best and cheapest form of transport, provided that it has enough to carry. When run to capacity in Tropical Africa it can carry produce for about 2d. a ton-mile.

(3) At present, for economic reasons, only arterial railways are possible in Tropical Africa. The average distance between them is over 300 miles, and there seems little prospect of this average being reduced.

(4) A railway in these areas develops commercially a strip of country about 50 miles wide on either side of it, but existing means of transport do not permit of development on a substantial scale much beyond this distance. These means of transport are described in paragraph (6). They are becoming more expensive as production increases.

The types of lorry now in use carry produce at about 1s. 6d. per ton-mile under favourable conditions. For a distance of only 50 miles this amounts to 75s. per ton, and for longer distances, up to the 150 miles required, the cost is prohibitive except for high-priced goods.

(5) The first essential, then, is a *main feeder* to drain effectively the inter-railway area and to fill the gap which exists between long railway transport at 2d. a ton-mile and short lorry transport at 1s. 6d. per ton-mile. This must be a form of transport capable of carrying produce at a much lower rate than the existing 2 or 3 ton lorry for a distance of 100-150 miles. To be cheap it must necessarily carry heavy loads, and at the same time must not give rise to heavy expenditure on roads.

(6) Such a main feeder could not economically collect produce in small quantities, and must be supplied by a system of *minor feeders*. These exist in Africa in the following forms:

Porters.
Pack animals.
Ox and mule wagons.
Motor lorries on wheels.

Each of these forms of transport has a justifiable economic sphere, but at present all of them are being used outside it, because each is attempting to act as a main feeder.

For small loads porterage is used over considerable distances, but, as wasting labour which could be better employed, should as far as possible be limited to distances of one or two miles, acting only as a subsidiary minor feeder.

Pack animals and ox and mule wagons are available only in certain districts and, excepting camels, do great damage to roads.

Motor lorries on wheels, from 10-cwt. to 3 tons, are now being used to a rapidly increasing extent in Africa for journeys up to 200 miles. Only goods of high value can stand a freight charge of 1s. 6d. per ton-mile over distances exceeding 50 miles, but at present there is no alternative. The economic range of motor lorries may be put, on the average, at 25 miles for 10-cwt. lorries to 50 miles for 3-ton lorries.

(7) The road is an essential part of both main and minor feeders, but roads constructed and maintained as in highly civilized countries are out of the question in Africa. The best that can be expected for many years are superficially metalled roads in the more populous areas and plain earth roads throughout the rest of the continent.

(8) In most Tropical African Colonies legislation has safeguarded the road by limiting the weight of vehicles to some 3 tons and requiring the use of pneumatic tyres. Up to the present this safeguard has been adequate because there is not sufficient production for the traffic to become intense. Certain roads, however, where traffic has been growing, are showing signs of rapid deterioration, and, if traffic on the present system is allowed to develop, the cost of road maintenance will rise rapidly.

(*b*) The Sub-Committee's Tests and their Conclusions.

(1) The damage done by a vehicle on a road depends primarily on the pressure per square inch of the tyre or track on the road, and secondarily on the speed. At a pressure of 12 lb. per square inch a rubber tyre or a track will actually improve an earth road, but so low a pressure is at present impracticable with wheeled vehicles. A pressure of 25 lb. per square inch is, however, practicable with the present type of semi-balloon tyres, but large tyres are needed to carry heavy loads. Thus, with 6-inch tyres, the limiting weights for this pressure are 1 to 1½ tons for a four-wheeled vehicle, to 3 tons for a six-wheeled vehicle with twin wheels on the two back axles.

Roads with lightly metalled surfaces will, we believe, withstand intensive traffic, provided the pressure is kept down to about 25 lb. per square inch and high speeds avoided. Earth roads, under the same conditions, will not withstand more than a light traffic. At present, lorry tyres are used with a pressure of some 90 lb. per square inch. Such high-pressure tyres are little better than solid ones in their effect on roads. If the practice be continued, the Colonies will find themselves faced with a ruinous expenditure on road maintenance wherever the traffic becomes intense.

Experiments have recently been made in the Sudan with two six-wheeled lorries, one with 100 lb. and the other with 20-30 lb. pressure in the tyres. Both in performance of the lorry and in the effect on the surface, whether soft sand or rough black cotton soil, the low-pressure tyres showed to advantage. See (*g*).

Research, however, is needed to ascertain the best diameter and pressure of tyres in relation to economical running on the one hand and damage to road surfaces on the other hand; also on the effect of tropical climates on rubber tyres.

Another point which requires investigation is the speed at which both wheeled and track vehicles can travel without seriously damaging African roads. It is clear that a high speed is desirable from the purely economic point of view of transport, but to the road-maker and the local administration, whose point of view is that the effect of vehicles on roads is little if at all less important than the effect of roads on vehicles, a low speed is essential, being far less damaging than a high one to the road surface. We are of opinion that the present high speeds of wheeled lorries will have to be reduced by some form of "speed governor," which will come into operation in accordance with speed on the road, and not with engine speed. With such a governor, vehicles would have their full power available on their lower gears.

(2) The first experiments were on two types of "half-track" vehicles, one with a Kegresse rubber track and the other with a Roadless Traction flexible metal track. These lorries ranged in size from 1 to 2½ tonners. These types were selected because the pressure per square inch of their tracks on the road was very low and their tractive effort high, and it was anticipated that they could traverse soft ground without doing damage to the surface, while hauling heavier loads than wheeled vehicles of equal power. These half-track lorries were, however, practically untried, and they were sent out to Nigeria to test the principle of the half-track, and with no idea of their competing commercially with wheeled lorries of the

same small capacity. We believed that, once the principle of the track itself was proved and its mechanical details perfected, the development of a half-track vehicle of economic type and size would soon follow.

It was found that these vehicles were entirely satisfactory in their effect on road surfaces, and an earth road was improved by them instead of being damaged. A year's experience has revealed various weak points in their design and construction, which have now been altered, and the vehicles are running well. It is too soon to say that all troubles have been overcome, but we are satisfied that only time and experience are needed to make them as reliable as wheeled vehicles.

The trials show that an ordinary 2½-ton lorry chassis fitted with a half-track and drawing a trailer will take a normal load of 5 tons at 15 miles an hour on earth roads, and will improve the road surface.

We incline, however, to the opinion that for loads up to 5 tons, four and six wheeled vehicles on low-pressure pneumatic tyres are the best means for transport. For higher loads half-track and full-track vehicles or tractors drawing trailers are preferable to wheeled vehicles, and are, at present, the only practicable means of transport on African roads.

(3) In the case of the metal-track vehicles, difficulties of construction diminish as the size is increased. A tractor has actually been built with a haulage capacity of 20-25 tons, and one to haul 100 tons has been designed. Whatever the size, the pressure per square inch on the road can be kept to a value of about 12 lb. It is believed also that the Kegresse tractor is susceptible of considerable increase in size.

We believe that the track tractor with a haulage capacity of not less than 20 tons, and preferably of 50 tons or more, can meet the requirements of a main feeder as discussed above. With an average load of 50 per cent. of its capacity, a 50-ton tractor with its trailers should be able to carry goods at 4d. to 6d. per ton-mile. It could use earth roads without doing them damage, and has the great advantage over a branch railway that it can vary its course to meet traffic needs. Though such a tractor would require permanent and expensive bridges over deep water, such bridges would be few in number, because this road train will be able to go through 3 feet of water.

The minor feeders to this main feeder could be the existing forms of transport, but in many cases there should be scope for half-track tractors hauling 5 to 20 tons at a lower rate per ton-mile than that of 3-ton wheeled lorries.

(4) The high cost of petrol in many cotton-growing areas induced us to investigate cheaper alternative fuels.

Alcohol.—Alcohol is now made and sold as a motor fuel both in Natal and Uganda. Exact facts are therefore available. It is not a business proposition to construct a factory for the manufacture of alcohol only. It can be and is produced economically as a by-product in the manufacture of sugar. The cost even so is high, probably about 2s. a gallon. It can be used successfully in the standard type of petrol engine with very little, if any, modification of the carburettor. Seeing that the economical exploitation of this fuel in Africa has already been effectively taken in hand by the sugar manufacturers, and that, even under the best conditions, the price is high, we confined our enquiry to a collection of the essential facts while preserving an open mind in regard to possible future developments of alcohol as a motor fuel.

Producer Gas.—Producer gas from charcoal, anthracite, or wood is the most promising alternative to petrol. It can reduce the fuel cost to about one-fifteenth that of petrol, and, the raw material being charcoal or wood, it would be a home-produced fuel. Charcoal is obtainable throughout the wooded parts of Africa at £1 or £2 a ton. In the Belgian Congo, lorries have been run on producer gas for many years. Its disadvantages are that the producer unit, with fuel, is heavy and bulky, that the engine has to be modified to avoid undue loss of power, and that about twenty minutes is required to start from cold. The weight and bulk are of importance in small vehicles, and the delay in starting is of importance when runs are short. For vehicles of 5 tons and over, on runs of 25 miles or over, these defects become insignificant, and would not militate against its use on larger vehicles in Africa. In England, however, the saving in cost of petrol is generally too small to outweigh the disadvantages, especially with the lighter types of vehicle, and the principal development can be expected only in the Colonies.

After examining a number of types, we acquired a Reading-Tulloch producer, and, with the collaboration of Messrs. Guy Motors, had it fitted to a Guy lorry with modified engine. The preliminary tests were entirely successful, both on anthracite and on native-made Nigerian charcoal, and the lorry has now been doing ordinary commercial work in England for the past six months. See (*h*). This experiment has now reached the stage when the lorry should be tried under local conditions.

Diesel Engines.—The Diesel type of engine working on crude oil cannot be said to have yet been perfected for road vehicles,

although extremely efficient and reliable both as a stationary and as a marine engine. Charcoal burning is a native industry in Central Africa, whereas crude mineral oil must be imported. Other things being equal, we are inclined to favour an engine consuming a local fuel. Apart from that, however, more mechanical progress has been made in the direction of perfecting an engine, suitable for use in vehicles, of the producer-gas engine type than of the Diesel type. We are watching with great interest the development of the Diesel engine for motor vehicles by such firms as the Avance and Polar-Diesel in Scandinavia, Peugeot-Tartrais in France, and Benz in Germany, but feel that the time is not yet ripe for trials of Diesel engines, though many of the objections would disappear if they were used as prime movers for heavy tractors of slow speeds.

(c) Recommendations for the Development of Transport and for Future Investigation and Experiment.

(1) We consider that the most important step to be taken is to evolve a main feeder transport unit by building a track tractor with trailers with a total capacity of 50 tons, trying it out in England, and then running it commercially in some area of Tropical Africa where there are actual or potential possibilities of production on a fairly large scale, provided that cheap transport is available. The details of such a tractor train have already been worked out, because a preliminary arrangement was made between the Sudan Government Railway and Roadless Traction Co. to carry out certain transport work in the Sudan by means of a 100-ton track train. To the regret of all concerned, it was decided that the project was not capable of immediate realization because it was found impossible to guarantee the requisite amount of produce.

(2) The present running of the three half-track vehicles under skilled observation in Nigeria should be continued. Though we feel that these vehicles are too small for half-tracks, the experience to be gained from them will serve for the larger vehicles which will have their economic sphere.

(3) A six-wheeled vehicle should be run, also under skilled observation, and should be used for research on the behaviour and running costs of low-pressure tyres of different sizes and with different pressures, and their effect on the road surfaces.

(4) Gas producers should be tried on native charcoal under local conditions.

(5) Road construction and maintenance and different types of bridges, culverts, and fords should be investigated, with reference to the different types of vehicles and tyres.

(*d*) Suggestions for Continuing the Work initiated by the Sub-Committee.

The investigations and experiments carried out have been financed up to the present by the Corporation. As, however, cotton-growing in the Empire is the primary interest of the Corporation, we hardly feel justified in advising them single-handed to finance the research and experiments recommended, important though they are. Moreover, the further investigations outlined above not only would depend on the assistance and interest of administrations on the spot, but are of such a scope that it would be almost imperative to obtain the assistance of various scientific and research bodies in this country, if the best results are to be obtained. Most, if not all of them, seem to be of interest to all tropical territories, and therefore, wherever they are carried out, it is desirable that there should be some machinery which will ensure that the results are given the widest possible circulation.

We are of opinion that, as at present constituted, we are neither sufficiently representative nor financially able to carry out this work. We suggest the establishment of some body which will specialize in the requirements of motor transport in the Tropics, and particularly in Africa; not only in respect of vehicles and their prime movers, but also in regard to roads. Such a body could be in close touch with and collect information from many territories. It could co-ordinate, tabulate, and compare results obtained everywhere; it could initiate tests and experiments, and advise local administrations and make available for their use the information thus gained.

As regards finance, it is suggested that if this scheme, or a modification of it, is accepted by any administration, they should make an annual grant for say a period of three to five years, to finance research and experiments, and that an appeal should be made also for assistance to those bodies and associations in trade that are likely to be interested.

(*e*) The Problem of Cotton Transport.

(1) Cotton transport varies in different territories according to local circumstances. It is not necessary to describe in detail the main differences in various areas, but two characteristic examples may serve to illustrate such variations.

In the cotton-growing area of Uganda, where there are many small ginneries in a comparatively limited area, and where road-making has to a certain extent been facilitated by the absence of transport animals, the growers have hitherto carried their seed cotton on their heads or backs to the nearest market or ginnery over distances which are rarely more than ten miles. From the ginneries the bales have been transported by lorries over a network of excellent roads to the nearest lake or port or railway at a cost of 1s. to 1s. 6d. per ton-mile. These methods of transport are showing signs of change. Each year the growers are less ready to carry their cotton to the buying centres, and a larger proportion is carried to the markets and ginneries in small lorries, the owners of which charge exorbitant rates, ranging from 2s. 6d. to 6s. per ton-mile. Apart from this, it is quite open to question whether 1s. to 1s. 6d. per ton-mile is really an economic price from the point of view of the lorry owners, many of whom are natives, who overload and overdrive their vehicles, and do not make allowances for a high rate of depreciation.

In Northern Nigeria, the areas in which exportable cotton is grown are more scattered than in Uganda, and pack donkeys, camels, and bullocks in large numbers have been in use for many years. Until quite recently, there have been few and large ginneries, and the roads are not as good as those in Uganda. A considerable proportion of cotton is bought in the fields by middlemen, but all exported cotton, before it is taken to the ginnery, has to pass through one of the recognized markets which are controlled and inspected by the Agricultural Department. After purchase at the markets, the seed cotton is carried either by motor lorry or by pack animals to the nearest ginnery, over distances ranging from ten to seventy miles. The distances over which seed cotton has to be transported by road are therefore far greater than in Uganda, and the expenses of this transport more than counterbalance the cheaper rail and sea freights of Nigerian cotton.

The present tendency in Nigeria is to increase the number of ginneries and to develop motor transport, because otherwise the area in which cotton can be grown is limited by the small carrying capacity of, and delays caused by, the use of pack animals. Quite apart from this, the amount of exportable produce has been increasing beyond the capacity of the pack animals available, with the result that the cost of pack transport is increasing to more than economic cost. It should be understood, however, that pack animals still have, and probably always will have, their uses provided they are employed on short leads over routes which are not fit for motors.

Such examples and such differences could be multiplied. Indeed, every cotton-growing area in Africa has its own particular problem, which consists in how to combine modern mechanical transport with existing methods of carrying cotton or other agricultural produce.

(2) Although the high price of cotton a few years ago made it possible to grow it at a profit in spite of heavy transport charges, such conditions are not likely to obtain permanently. Three years ago the average price of American middling cotton during the season was 17·66d., and as the price of so much of the world's cotton is based on that of American middling, the price of African cotton was correspondingly high and the proportion of transport cost was relatively small. To-day, however, while the average price of American middling has fallen, the cost of transport has remained the same or has become a little greater owing to increased production, and therefore increased demand for transport. As the actual grower has to bear this cost, or the greater part of it, it is evident that, in cases where the cost of growing can be calculated with any accuracy, the grower has only a very small margin of prôfit, while in those cases where natives do not and cannot calculate their costs, and can indeed afford to grow cotton when the price of American middling is very low indeed, they are nevertheless discouraged and perturbed, for they cannot understand the fluctuations in price of a commodity which is sold in many of the world's markets. For these reasons alone lower transport costs are essential. It is, of course, impossible to foresee the future fluctuations of cotton prices, but it is to be hoped that, for the sake of the Lancashire industry, prices will remain, not only reasonably low, but much steadier than they have been in the years since the war. If they do, and cotton-growing in the Empire may do much to stabilize prices by developing cotton fields in many areas which are not all likely simultaneously to be affected by climatic and other conditions, then the transport charges will be of very great importance, and cotton will become more and more comparable to other comparatively low-priced agricultural commodities, of which some cannot even be exported from Africa at the present time because the cost of moving them is more than they are worth. As an example of what expensive transport means, it was found that in 1925 the growers in the Punjab were actually being paid more for their seed cotton than were the farmers in Uganda for cotton of much superior quality. This was mainly due to transport, though high ginning charges were also to a certain extent responsible.

(3) If cotton is to be grown successfully, it is almost essential to grow it as a rotational crop, and therefore the transport of other and lower priced rotational crops must be facilitated so that they also can be exported. This conclusion is based on scientific agricultural opinion, and has been confirmed by many reports received by the Corporation since its formation. In some territories, such as Nyasaland, it has become increasingly difficult to grow cotton owing to the attack of insect pests, the depredations of which a sound rotational system of farming can minimize if not eliminate. Transport from that territory is, however, so expensive that the cheaper crops cannot be exported, and therefore are not grown, because the local population is not large enough to provide more than a very small internal market. In Rhodesia, on the other hand, European farmers have found that it is worth their while to grow cotton, even when prices are very low, on account of the much improved yields of maize obtained on land where cotton has been grown the previous year. It is evident, therefore, that the cultivation of cotton in tropical countries is merely one of several farming operations, and that its transport involves that of agricultural commodities in general.

(*f*) Roads in Tropical Africa.

Roads in Africa are, and must be, of a type that requires special vehicles. They are bound to cover great distances because it is economically impossible to cover any part of the continent with a network of railways such as exists in most highly-developed countries, and the gaps between the railways are large. They are also bound to traverse stretches of country which are unproductive and barren, either because the population is sparse, or, agriculturally speaking, backward, or because there are great stretches of desert which separate potentially productive areas. For financial reasons the heavily-metalled, perfectly surfaced roads of this country are impossible, and for many years to come roads in Africa must be either unmetalled "earth" ones or lightly metalled ones surfaced with a thin layer of laterite gravel like the roads of Uganda, which are probably the best in Africa.

It is obvious, therefore, that vehicles evolved for use in highly-industrialized temperate countries are not necessarily serviceable in the Tropics, while vehicles specially designed for tropical conditions may not be entirely suitable for use in England.

Although roads in the Tropics vary in construction and main-

tenance to suit local circumstances, almost all the following difficulties have to be considered and overcome:

(*a*) The scour and erosion caused by tropical rain storms.
(*b*) The vigorous growth of vegetation.
(*c*) The expense of good metalling.
(*d*) The great distances that have to be traversed.
(*e*) The expense of bridging.
(*f*) The damage caused by primitive carts and all transport animals except camels.

During their investigations, nothing has impressed the Committee so much as the differences in opinion regarding the best type of road and the most economical method of road construction and maintenance among local experts, and the fact that few had given serious attention to the damaging effect of vehicles, and how this could be minimized.

There were some who held that all important roads must be metalled as heavily as possible, and built as "all-weather" roads. Others held that the native-made earth roads were the best type, and that all available money should be spent on making fords passable with "Irish bridges," and on bridging streams and swamps with solid permanent structures capable of carrying very considerable weights.

There is a great deal to be said for the latter view because to a large extent it is true that once a road always a road, many modern main thoroughfares in England having been in existence as trackways in prehistoric times. Moreover, in many areas agricultural produce is transported during the dry season, and therefore very little transport is moving during the rains.

While we do not feel competent to lay down what is the best type of road for Africa, we offer the following suggestions:

(1) That where transport animals, except camels, exist in any number they should be made to use a road other than that which is intended for motor vehicles. In this connection it should be pointed out that the excellence of the roads in Uganda, while reflecting the greatest credit on the Administration and the Public Works Department, is probably in very large measure due to the absence of any kind of transport animals in that Protectorate, and that from the road-makers' point of view the tsetse fly is a blessing in disguise.

(2) That high-speed lorries are very destructive to lightly metalled roads, and that a maximum speed of 15 m.p.h. for lorries with loads of more than 1 ton would be quite sufficient.

(3) That road reserves of at least 100 yards in width are desirable so as to prevent encroachments in the shape of buildings, native gardens, etc., close to any road. Such encroachments almost inevitably lead to damage and make future realignments difficult. The principle of road reserves is followed in India with good results.

(4) That what is required even more than a good surface is one that is wide and well drained, with ditches at a considerable distance from the actual road.

(5) That gradients, especially where leading to and from fords, should be eased to about 1 in 10.

(6) That there is a great deal to be said for the Irish bridge, especially in areas where there is a sufficient period of dry weather for transport purposes; culverts and small bridges are often the cause of erosion because they tend to concentrate flood water.

(7) That where a bridge is necessary, it should be a permanent one, capable of carrying even heavy road trains such as are described in this memorandum.

Finally, we recommend most strongly that this question of roads should be treated as being inseparable from that of modern developments in transport vehicles, that the effect of vehicles and traffic generally on roads should be studied, and that it is most desirable to pool and disseminate, not only to technical but to administrative officers, all information about road building and maintenance, experimental types of roads and bridges, and the possibility of standardizing the latter.

(*g*) Note by the Director of Mechanical Transport, Sudan, on High and Low Pressure Tyres.

Two identical Rigid Six-Wheel Thornycroft lorries, carrying two tons each, were tried over some small mounds of dry wind-blown sand near Khartoum. One lorry had the normal pressure—viz., 100 lb. in all tyres—and the second had between 20 and 30 lb. per square inch. The tyres were all the same, being new 40×8″ Dunlops (high-pressure type).

The lorry with high pressures in the tyres failed as soon as all the wheels got into soft sand. The failure was due to the wheels sinking in and wheel-slip taking place.

The lorry with low pressures in the tyres went over the soft sand easily on the flat, and also over small mounds, and only stalled when

attempting to climb up the side of a steepish mound. This failure was also due to the wheels sinking in and slipping.

The difference in the depth of impress of the tyre tread was of great interest. The high-pressure tyre always sank so deep that the tread impressions were covered up after the passage of the wheel by the sides of the trough so made falling in. The tread impressions of the low-pressure tyres were perfectly clear-cut and sharp on the top of the sand until the limiting point of adhesion was reached and wheel-slip occurred.

Over hard ground the lorry with the low pressures was found to ride easier, and there was much less tendency for the front axle to bounce. This latter trouble was particularly noticeable in the high-pressure-tyred lorry when traversing rough cotton soil. The steering of the low-pressure lorry was, however, noticeably heavier, and there was naturally some tendency to roll when turning sharply.

It was observed that the pattern on the tread of the tyre appeared to be a definite disadvantage in sand as it allowed the sand to flow away from under the tread. It is considered that a plain square tread would be better, or possibly one with circumferential grooves. The advantages of the grooved tread of the Dunlop type appear very doubtful (for this country), because the condition of a road surface with a thin greasy covering is met with very rarely, the roads or tracks in these parts either being dry or, after rains, forming heavy mud, necessitating the use of non-skid chains.

There would, therefore, appear to be a *prima facie* case for the development of low-pressure tyres for lorries, such tyres to have plain treads, or at all events treads without transverse grooves or patterns equivalent thereto. Not only will such tyres enable lorries to cross soft sand that would be otherwise impassable, but less damage will be done to earth roads.

There is, however, one very important essential requirement of these low-pressure tyres—they must be as proof against punctures as the high-pressure ones. In small cars—*e.g.*, Fords and Renaults—low-pressure (balloon) tyres have been found very unsatisfactory owing to innumerable punctures. These punctures are produced by thorns and small tree stumps, which are very common on all sandy routes in the Sudan. The thorns are not long or strong enough to penetrate through the tread of a high-pressure lorry tyre. Tree stumps do occasionally penetrate, but comparatively rarely.

It is therefore hoped that tyre manufacturers will take up the development of a low-pressure tyre to fulfil the requirements of such countries as the Sudan.

(*h*) Suction Gas Producers.

A portable suction gas producer suitable for fitting on a motor lorry generates gas on a small scale by the same method in principle as that used for making gas from coal for lighting a city. Briefly, air is drawn through an incandescent mass of fuel, in this case anthracite or charcoal, in an enclosed chamber. The gas thus formed is sucked through pipes and various cleaning devices to the engine, and having been mixed with several times its own bulk of air, is drawn into the cylinders and exploded in the usual way. The only advantage that this system has over the ordinary petrol engine is economy. Where suitable fuel is cheap, as in Africa and in some countries of Europe, power can be obtained from a suction gas engine at a fraction of the cost of a petrol engine. For instance, charcoal at £1 per ton provides power at a price which could only be developed by a petrol engine if petrol were 2d. a gallon. As petrol in Africa costs 3s. and more per gallon, the saving is very marked, particularly where high powers are in question. In England, with anthracite at £4 per ton, charcoal at £8 or £9 per ton, and petrol at 1s. 1d. per gallon, the saving is less obvious, especially where only comparatively low engine power is required.

A producer-gas engine has the disadvantage, as against the petrol type, that it cannot be started at a moment's notice from cold. A fire has to be lighted and blown up by hand before the engine can be set in motion. This operation takes perhaps fifteen or twenty minutes. Here again the objection is more felt in England with its short journeys and high-priced labour than in Africa, where the distances are great and a native can be given the task of lighting the fire and blowing it up.

We have gone carefully into the construction of a number of gas producer plants which were recommended for use on motor lorries. In 1926 we decided in favour of the Tulloch-Reading plant, which seemed to have made the most progress towards overcoming the initial difficulties with which the early development of these plants is faced, such as:

(*a*) The tendency on a long continuous run to a gradually increasing temperature in the gas which will, unless checked, rise to such a pitch that the value of the gas will be much reduced by combustion before it reaches the engine. This feature has been turned to advantage in the Tulloch-Reading producer by a simple lever under the driver's control, by which a water feed

to the combustion chamber is regulated. The heat of the fire turns this water into steam, which is drawn with the air through the fire, thus cooling the fire to any required extent, and adding at the same time the valuable constituents of the water (oxygen and hydrogen) to the gas. Thus the driver can keep absolute control of the temperature of the gas well within the 200° F. permissible variation by merely operating a lever on the steering column.

(*b*) Formation of tar, a natural by-product of combustion of anthracite or charcoal. The effect of tar in engine cylinders is disastrous. This evil can, however, be eliminated by drawing the gas through the centre of the fire; the tar is thus completely consumed or " cracked " into its elements and disappears.

(*c*) Soot and grit passing with the gas into the engine. Filters, or scrubbers, for the gas are provided in the form of hollow cylinders packed with wood wool, which effectively trap any particles of solid matter carried over by the gas. These scrubbers are made with quickly detachable heads in an accessible position, in order that changing the filtering material may be neither a laborious nor a disagreeable operation.

Finally, the type of engine which operates best on producer gas is not identically the same as the type which operates best on petrol gas. The compression in the former should be higher, and the speed of travel of the gases should be slower in order to get the best results. Even under these conditions, a producer-gas engine will develop about 20 per cent. less power than a petrol engine of the same cylinder capacity. It is not satisfactory to attempt to put a producer-gas plant into a standard chassis with a standard petrol engine. The required modifications are, however, not fundamental. It is usually possible to fit an engine of 20 per cent. greater cylinder capacity into a standard chassis, particularly if the stroke has been lengthened. Increased compression means a redesigned cylinder head. Slower gas speed calls for larger valves or a longer lift.

In 1926 arrangements were made to carry out tests jointly on a Tulloch-Reading producer-gas plant mounted in a standard 2½-ton Guy four-wheeled lorry chassis, but fitted with an engine 4½-inch bore by 5½-inch stroke with the head modified to give higher compression, and the valves a longer lift than in the standard engine, 4-inch bore by 5½-inch stroke.

The lorry was first tested on anthracite, and, with a load of 2½ tons which gradually diminished to about 2 tons, was run for 1,100

miles. The fuel consumption was 17½ cwt. (1,960 lb.), and the vehicle would do from 27 to 30 miles an hour. There was only one involuntary stop, and that was due to the tube of the vapourizer becoming unwelded. For the first 600-700 miles the vehicle was driven by Mr. Reading, the last 500 miles by one of the works drivers, who reported that there was no difficulty in controlling the vehicle when running on gas. Except that it was necessary to adjust the air-control lever whenever an appreciable change of engine speed took place, the driver noticed little difference between this and a petrol-driven vehicle. The acceleration seemed to be about the same. and on top gear it would run as slowly on gas as on petrol. The actual power was, of course, less than on the petrol-driven model; exactly how much less has yet to be ascertained.

The engine was not touched or opened up until 1,100 miles had been run. It was then found to be in a satisfactory state, hardly distinguishable from an engine which had been run similarly on petrol.

Oil from the crank case was submitted to analysis. Two and a half gallons had been added in the course of running. The oil was tested for viscosity, water content, and foreign matter. The viscosity was unimpaired. There was a slight trace of water, traces of foreign matter, and no acidity. These results are considered to be entirely satisfactory.

Preliminary tests on charcoal, sent for the purpose from Nigeria, show that more power is obtainable from gas generated from this fuel than from anthracite. These tests have not yet been concluded, but the latest report is to the effect that, in the hands of an unmechanical and not particularly skilled driver, the vehicle has behaved quite satisfactorily, and that, with a load of 2½ to 3 tons, the consumption of charcoal on hard roads is 2 lb. per mile.

TECHNOLOGICAL REPORTS ON STANDARD INDIAN COTTONS*

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I. General Introduction.

Objects of Tests.—The tests described in the present bulletin are all related to one fundamental problem—viz., the determination of the intrinsic value of a cotton. As is pointed out by Dr. Lawrence Balls in his "Handbook of Spinning Tests for Cotton Growers," the intrinsic value of a cotton may be a very different thing from its market value. It is possible to fix standards of intrinsic value, having regard to the quality of yarn which can be made from the cotton, the behaviour of the cotton during spinning, and the amount of waste to which the cotton gives rise. But it is quite impossible to fix absolute standards of market value. The market value of cotton at any time is, of course, a reflection of the supply and demand then existing; moreover, the "on" or "off" allowances for superior or inferior cottons also fluctuate according to the operation of the economic factors for such cottons as compared with their operation for the basic standards. Beyond this, a new cotton may not receive its full market value, as compared with other cottons, either because only small quantities of it are available, or because its intrinsic value is not fully appreciated; with an increasing supply and an enlarged experience of the new cotton, however, this state of affairs would gradually rectify itself.

The chief factors concerned in the intrinsic value of a cotton have been mentioned above—quality of yarn spinnable, behaviour in spinning, and wastiness. These three factors are at present all dependent for their determination on an actual spinning test, and a subsequent examination of the spun yarn. They cannot all as yet be accurately predicted simply from an examination of the raw cotton, for there is evidence available that a cotton-grader's valuation

* Reprinted from Bull. No. 7, Technol. Ser. No. 3, Ind. Cent. Cotton Comm. Technol. Laboratory, March, 1927, which can be obtained from the Indian Central Cotton Committee, 25, Wodehouse Road, Bombay. The first nineteen pages of the Report have been reprinted here, as they contain an extremely interesting and detailed account of Spinning Tests on Indian Cottons. A number of references to later portions of the Report appear in these pages, and have been allowed to stand to enable the reader to appreciate the ground covered by Mr. Turner. The whole of the bulletin could not be reprinted by reason of its bulk.

of a cotton—which is his assignment of its market value based on his judgment of its intrinsic value—is liable to err when he is dealing with a new and therefore unfamiliar type, and it remains to be seen whether it will in the future become possible to displace the spinning test and to determine the intrinsic value merely by a scientific examination of the cotton by methods more precise than those of the grader. The results of tests on the standard Indian cottons now being published comprise the beginning of the accumulation of data to this end. It will be observed that, for each cotton, details are given of the size of the crop (where known), of the grader's report, of the fibre tests, and of the spinning test, including the spinning particulars, the waste percentages, the yarn test results, and the physical conditions during the testing, together with the Spinning Master's report and a yarn examination report. The import of these features is discussed in some detail later.

Besides this general object of accumulating data, however, there are four specific objects which these tests are intended to subserve. These objects are:

(1) To determine the extent to which these standard cottons are affected by seasonal variations.

(2) To obtain as full information as possible about the standard Indian cottons, both as to their fibre characters and their spinning capacities.

(3) To have a series of standards available by which to judge other cottons, particularly new cottons produced by cotton breeders.

(4) To determine the minimum weight on which a spinning test of a cotton sample can be carried out satisfactorily.

List of Standard Cottons.—The cottons which have been chosen in the first instance as standard Indian cottons are those more or less recent Agricultural Department selections which have passed into extended cultivation. These are the following:

Bombay Cottons :	*Seasons.*
1. Dharwar No. 1 (Kumpta)	1923–24, 1924–25, 1925–26.
2. Gadag No. 1 (Dharwar-American)	1923–24, 1924–25, 1925–26.
3. Surat 1027 (A.L.F.)	1923–24, 1924–25, 1925–26.
Punjab Cottons :	
4. Punjab-American (4F)	1924–25, 1925–26.
5. Punjab-American (285F)	1923–24, 1924–25, 1925–26.
6. Punjab-American (289F)	1924–25, 1925–26.
7. Mollisoni*	1925–26.

* A strain of *G. Indicum Mollisoni* (Gammie), a constituent of Punjab desi cotton.

United Provinces Cottons:

8.	Aligarh (A. 19)	1924–25, 1925–26.
9.	Cawnpore (K. 22)	1924–25, 1925–26.
10.	Bundelkhand (J.N. 1)	1924–25, 1925–26.
11.	Cawnpore-American (C.A. 9) ..	1924–25, 1925–26.

Madras Cottons:

12.	Coimbatore (Cambodia 295) (Co. 1)	1923–24, 1924–25, 1925–26.
13.	Nandyal (Sircar) 14 (Northerns) ..	1923–24, 1924–25, 1925–26.
14.	Hagari (Sircar) 25 (Westerns) ..	1923–24, 1924–25, 1925–26.
15.	Karunganni "C"	1923–24, 1924–25, 1925–26.

Hyderabad Cotton:

16.	Umri Bani	1924–25, 1925–26.

For purposes of comparison, some American cottons have been introduced into the series: these are:

17.	Mississippi	1923–24.
18.	Memphis	1925–26.
19.	Texas	1923–24, 1925–26.

The present note is devoted to a fairly detailed discussion of the following:

(1) The reasons why it is important to know what is the minimum weight of cotton necessary for a trustworthy spinning test;
(2) The validity of adopting a special routine for spinning tests on small samples;
(3) The special routine adopted at the Technological Laboratory for spinning tests on small samples;
(4) The various examinations and tests to which the raw cottons and the spun yarns are respectively subjected;
(5) The various general results which have been obtained in the series of spinning tests herein reported on.

The Minimum Weight of Cotton necessary for a Spinning Test.—It has already been stated that in the course of these tests on the standard cottons an answer has been sought to the question: What is the minimum weight of cotton necessary for a trustworthy spinning test? The importance of this question lies in the fact that when a cotton breeder has produced a new strain, he has to multiply it for three generations in order to obtain even a few pounds of lint. Yet he strongly desires to have a spinning test made on a sample at the earliest stage possible, because at the present time the spinning

test affords the only reliable guide to the quality of the cotton. Moreover, a cotton breeder grows a number of strains at one time; he has neither the time, nor the staff, nor the land available for growing large quantities of all his strains. At a certain stage, therefore, he cannot continue to multiply all of them; circumstances compel him to select some and to reject the others. Evidently his work will be very much facilitated if a reasonably accurate spinning test of his cotton can be made when only about 10 lbs. of lint of any given strain are available, and he will be correspondingly hampered if he is asked to provide at least 100 lbs. of lint for the spinning test.

As indicated above, the value of the spinning test lies entirely in its being a guide to the quality of the cotton, and therefore to its intrinsic and ultimately to its market value. But the spinning test result by itself does not enable the cotton breeder either to retain or to reject any given strain, for this is only one of the factors which have to be considered from the agricultural standpoint. The fact is that the ultimate test of any variety is the average monetary return which it yields per acre under perfect marketing conditions, and this involves two factors—viz., the spinning value of the cotton, and the yield of ginned cotton per acre. These two factors depend on a number of plant characters, many of which are imperfectly understood, so that extended field tests are necessary before any variety can be brought to the notice of cultivators. In these circumstances, the value of the spinning test lies in the help it affords the breeder when classifying his strains into: (1) Strains worth multiplying and extended field-testing; (2) strains worth further study; (3) strains not worth multiplying. By acting in accordance with this classification in the following season, he will obtain for the spinning tests larger quantities of the cottons of class (1); he will simply maintain and not multiply the cottons of classes (2) and (3), and so even of these he will obtain sufficient lint to allow of further small-sample spinning tests, the results of which will serve to check the conclusions for the previous season's crops. It is important to notice that no final decision as to the fate of any given type would be based on the results of a spinning test on 10 lbs. weight of cotton lint of a single season. The whole question, therefore, resolves itself into this: Are the results from tests on a 10-lbs. sample of cotton sufficiently trustworthy to be used as a guide in the sense indicated above? An affirmative answer to this question is provided by the series of tests described in the present reports.

The Validity of a Special Routine for Spinning Tests.—It must here be emphasized that the conditions under which the spinning

tests are made in the Technological Laboratory are specialized. They are not the same as the conditions prevailing in a mill, because the conditions in the Technological Laboratory have, in fact, been specially arranged for carrying out these spinning tests. The governing factor in mill practice is that of getting the highest possible production of the given quality of yarn being spun. Hence its personnel is necessarily inexperienced in handling small samples, and the whole routine of a spinning mill is naturally ill-adapted for this purpose. In the Technological Laboratory, on the other hand, everything is specially adapted for making tests on small samples, the operatives have been trained in the type of work required, and owing to the smallness of the plant, it is possible to exercise the closest expert supervision throughout. The special routine now adopted will be described in full detail later. This special routine appears to have led to some misapprehension. It has been contended that such detailed treatment is impossible in a mill, and so is no guide to what will occur under practical conditions. It is, of course, true, as already pointed out, that this detailed treatment is normally impossible in a mill; it was this very reason which led to the installation of a complete spinning plant in the Technological Laboratory. *But the whole aim of the special routine adopted in the Technological Laboratory is to give such a treatment in the spinning test on a small sample of cotton that the results will provide a reliable guide to what may be expected when the cotton is spun under practical conditions. The special routine has been adopted solely with this end in view.*

It is possible, by considering in turn the various stages of spinning, to see where the treatment for a small sample is likely to be defective or advantageous as compared with the treatment of cotton in bulk under mill conditions. The most likely place for defective treatment to occur is in the blow room, where it is difficult to make a uniform lap for the card out of the small amount of material available. The difficulty cannot be entirely overcome, but what can be done is to avoid using in the subsequent tests the material made from the irregular parts of the lap. If due attention is given to this in the manner explained later, there is no doubt that a scutcher lap can be prepared of normal uniformity in its central portion, which can then be used for the subsequent tests. The treatment of the small sample in the later stages is probably superior to that which would be possible under ordinary mill conditions. This is simply because much closer supervision can normally be exercised at each stage in the Technological Laboratory.

The spinning spindles in the Technological Laboratory are all numbered, and for each lot of cotton ten bobbins are taken for test purposes from spindles 1-10, while for the duplicate lot (any sample submitted is normally spun in duplicate lots) another ten test bobbins are taken from spindles 73-82. The same spindles are used to provide the test bobbins for every sample, and each test bobbin is numbered to show the spindle on which it has been spun. Records are maintained for each individual spindle as to the yarn breakages sustained thereon during the spinning of each type of yarn; the results of the subsequent tests on each yarn are also recorded separately for each individual bobbin. Data are thus obtained which make it possible to compare the working of the several spindles, and thus to ascertain whether each of them is working truly or not. It may be thought that this procedure is unduly favourable to the cotton. *But it has to be remembered that the spinning test is above all other things a test of the sample of cotton, and for this reason it is essential to keep the treatment in the machinery as constant and as much under control as possible.* By the system adopted at the Technological Laboratory it is at least ensured that all samples are compared under as similar conditions as possible so far as the machinery is concerned. That this is most desirable in the conduct of spinning tests on cotton can hardly be gainsaid. From these considerations the conclusion is therefore drawn that on the whole it is to be expected that the results obtained in the Technological Laboratory will approximate to those obtained under the best mill conditions.

II. Details of Spinning Tests.

Weights of Samples.—As previously mentioned, it was desired that these tests on the standard cottons should furnish definite information as to whether satisfactory spinning tests could be made on small samples. In order to achieve this object, the various cottons were generally tested in a number of lots having the following initial weights:

100 lbs., 10 lbs. 5 lbs. (2 lots). 2 lbs. (2 lots).

It appeared that it was only by such series of tests that it would be possible to obtain definite knowledge concerning the degree of reliability of tests on small samples.

Machinery Details.—The machines normally used for the spinning tests are listed below, together with certain details as to speeds, etc., at which the machines are run:

Blow Room Machinery.

(1) One (Porcupine) Lattice Feeder; porcupine speed 750 r.p.m.
(2) One Crighton Opener; beater speed 750 r.p.m.
(3) One Hopper Feeder.
(4) One Scutcher; three-bladed beater speed 1,000 r.p.m.
Weight of lap : $12\frac{3}{4}$ ozs. per yard.

Card Room and Spinning Machinery.

(5) Two Revolving Flat Cards—

Cylinder speed formerly (up to Sample No. 56) 190 r.p.m. now 160 r.p.m.
Doffer speed 14 r.p.m.
Flat speed formerly (up to Sample No. 56) 4 inches per minute, now 3 inches per minute.
Hank: 0·13 for 10's; 0·17 for 20's only; 0·18 for 20/40's.

(6) One set of Drawing Frames—

Front roller speed 350 r.p.m.
Front roller diameter $1\frac{3}{16}$ inch.
Hank: 0·16 for 10's; 0·19 for 20's only; 0·20 for 20/40's.

(7) One Slubbing Frame (36 spindles)—

Front roller speed 210 r.p.m.
Front roller diameter $1\frac{1}{8}$ inch.
Hank: 0·55 for 10's; 0·71 for 20's only; 0·77 for 20/30's; 0·85 for 20/40's.
Spindle speed 650 r.p.m.

(8) One Intermediate Frame (50 spindles)—

Front roller speed 156 r.p.m.
Front roller diameter $1\frac{1}{16}$ inch.
Hank: 1·00 for 10's; 1·65 for 20's only; 1·70 for 20/30's; 1·85 for 20/40's.
Spindle speed 780 r.p.m.

(9) One Roving Frame (64 spindles)—

Front roller speed 132 r.p.m.
Front roller diameter 1 inch.
Hank: 2·00 for 10's; 3·70 for 20's only; 4·30 for 20/30's; 4·75 for 20/40's.
Spindle speed 1,160 r.p.m.

(10) Two Twist Ring Frames (48 spindles each)—
Spindle speed for counts up to 10's, 7,600 r.p.m.
Spindle speed for counts 20's and above, 8,600 r.p.m.
Other particulars are given in the tables for each sample separately.

Method of indicating Spinning Value.—We may consider two methods by which the relative spinning capacities of various cottons can be indicated. The first method is by reference to their spinning performance at some one definite count; the second method is by reference to the highest count of standard warp yarn (see p. 307) into which each cotton can be spun, as deduced from spinnings of that cotton into a number of different counts. In some ways the second method appears preferable. The chief advantage of the first method is its simplicity; one objection to it, however, is that it cannot have general application because there is no one definite count at which it would be satisfactory to compare all cottons. If the definite count adopted were sufficiently low to be practicable for poor cottons, it would be too low for a good cotton, because from the results for the good cotton at the low count it would not be possible to deduce the highest count for which it would be suitable, seeing that extrapolation outside narrow limits is not justifiable. When this method is used, therefore, it is necessary to divide cottons into various classes, any one cotton being spun into some definite count according to its class, and the comparison confined to that class. This, of course, entails the partial adoption of the second method. The great advantage of the second method is that the spinning of different counts automatically provides many additional checks on the results.

The method adopted at the Technological Laboratory, as will be clear from the description given below, combines the advantages of both the above methods. Each sample is divided into two separate lots; each of these duplicate lots is then spun into three different types of yarn, so that the final decision as to the spinning capacity of a cotton is based on the test results for six different sets of yarns. Differences may and do occur between the duplicate test results for any one count of yarn, so that on these alone it would sometimes be difficult to arrive at a satisfactory conclusion; but with results available for three types of yarn in duplicate this difficulty is surmounted, and it is invariably found possible to draw a fairly accurate conclusion as to the highest count of warp yarn of moderate twist for which the given sample is suitable. In arriving at this conclusion, due

weight is given to the performance of the sample during the various spinning processes, to the numbers of breakages per ounce of yarn spun on the ring frame, and to the yarn test results, chiefly those for counts, lea strength, and twist. The standards which have been adopted for twist and strength are discussed in the following paragraphs.

Twist Standards.—In order to preserve a uniform basis of comparison, all yarns are spun with a medium degree of twist only. This limitation of "medium twist" is imposed because it is always possible, of course, by increasing the twist above a moderate amount, to spin finer yarn or to obtain greater proportionate strength with fewer breakages. The insertion of more twist *per se* leads to a decreased production, however, and, for most purposes, to a less desirable yarn, so it may not prove economical in practice, even though it produces less waste. In any case, the behaviour of a cotton with moderate twist is a guide to its behaviour with a harder (or softer) twist, and it is preferable for the spinning test to use moderate twist as a standard condition.

The twist standards actually employed are three in number: they are the so-called twist constants* 3·75, 4, 4·25. These twist constants are taken as covering the range denoted by moderate twist. So far as the sample supplied will permit, it is first spun into yarn of 20's counts with the twist constant 3·75. If the results in this count justify it, the cotton is then spun into either 30's or 40's yarns, or both, with one or both of the other twist constants. Cottons of very poor staple, however, are spun at once into 10's counts with the twist constant 4, and other possible counts decided upon from the results for the 10's. The actual spinnings must depend upon the results of the preliminary tests; in some cases 20's yarn is spun with the 3·75 twist constant, 30's yarn with the 4 twist constant, and 40's yarn with the 4·25 twist constant. A less good cotton may be spun into 20's yarn with the 3·75 twist constant, 30's yarn with the 4 twist constant, and 30's yarn again with the 4·25 twist constant. The normal practice in any case is, as stated above, to make spinnings of three types of yarn.

Strength Standards.—The following table shows the standard breaking strengths and corresponding count strength products which have been adopted for various counts of moderately twisted warp yarn subjected to the lea test:

* The twist constant is a number which, when multiplied by the square root of the counts being spun, represents the number of turns of twist inserted per inch of the yarn—*i.e.*, $N = K\sqrt{C}$, where N = number of turns of twist per inch of the yarn; C = counts being spun; K = twist constant.

TABLE OF STRENGTH STANDARDS FOR VARIOUS COUNTS.

Count.	*Breaking Strength.*	*Count Strength Product.*
Up to 14	90	1,260
16	81	1,296
18	73	1,314
20	67	1,340
22	62	1,364
24	58	1,392
26	54	1,404
28	51	1,428
30	48	1,440
32	46	1,472
34	44	1,496
36	42	1,512
38	40	1,520
40	39	1,560

Cotton yarn spun warp way with moderate twist and having the lea strength specified in the above table for the corresponding count is hereafter referred to as " standard warp yarn."

The above table has been designed for the purpose of differentiating between cottons according to their respective spinning capacities; no single cotton sample, therefore, could satisfy its requirements at all counts. Its application will become evident on consideration of what happens when a given cotton is spun into more than one count. Now the numerical count of a cotton yarn varies approximately inversely as the fineness, so that a 20's yarn (say) will have twice as many fibres in its cross-section as a 40's yarn spun from the same cotton. It might therefore be supposed that the 40's yarn, if spun with equivalent twist (*i.e.*, with the same twist constant), would be half as strong as the 20's, and that a cotton giving a standard 20's yarn breaking at 67 lbs. would give a 40's yarn breaking at 33·5 lbs. In point of fact, this is not the case. The reasons for this need not be discussed here, but the fact remains that if the " 20's cotton " could be spun at all by machinery into 40's yarn, the strength of the 40's would be actually less—very much less—than 33·5 lbs.; conversely, a " 40's cotton " (giving a 40's yarn having a strength of 39 lbs.) would give a 20's yarn having a much greater strength than 78 lbs.

The consequences of thus " spinning up " a 20's cotton and of " spinning down " a 40's cotton may be illustrated by some results obtained with Punjab-American 4F (a typical 20's cotton) and Memphis (a typical American 40's cotton). Each of these cottons was spun into 20's, 30's, and 40's counts with the 3·75 twist constant, and also into the same counts with the 4 twist constant. The results were as follows:

Cotton.	*Twist-Constant.*	*Counts Nominal.*	*Counts Actual.*	*Lea Strength Lbs.*	*Count Strength Product.*	
					Actual.	*Percentage of Value for 20's.*
Punjab-American 4F	3·75	20	19·7	75·8	1,493	100
	3·75	30	30·5	34·8	1,061	71
	3·75	40	39·0	21·2	827	55
Memphis	3·75	20	20·3	100·4	2,038	100
	3·75	30	29·8	57·6	1,716	84
	3·75	40	41·0	36·1	1,479	73
Punjab-American 4F	4	20	20·0	79·4	1,588	100
	4	30	30·9	39·6	1,223	77
	4	40	37·8	28·9	1,092	69
Memphis	4	20	19·6	100·8	1,976	100
	4	30	30·0	57·6	1,728	87
	4	40	40·3	37·5	1,511	76

These results bear out what has been stated above: the Punjab-American 4F spun with the 3·75 twist constant gives a 40's yarn having only 28 per cent. instead of 50 per cent. of the strength of the 20's yarn, while the Memphis cotton gives a 20's yarn having 2·7 times the strength of the 40's yarn instead of only twice its strength.

It is important to observe, however, that in the table of strength standards the breaking strength required for a 40's yarn is not merely half that required for a 20's yarn, but even more than this—viz., 39 lbs. instead of 33·5 lbs. The table therefore provides a scale which makes a fairly severe demand for increased quality as the counts become finer. Underlying the scale is the general principle that, as the count increases, there is in the " breaking strength required " a fall which is less steep than the rise in count—*i.e.*, the count strength product increases as the count increases. This, as already indicated, is just the opposite of what happens for a single cotton spun into different counts. In the latter case, as the count increases there occurs in the breaking strength a fall which is more steep, not less, than the rise in count—in other words, for a given cotton the count strength product decreases as the count increases. If, therefore, curves are plotted showing the relation between the counts and the count strength products as required by the scale and as given by any particular cotton spun into different counts, these curves are bound to intersect; and it is the point of intersection

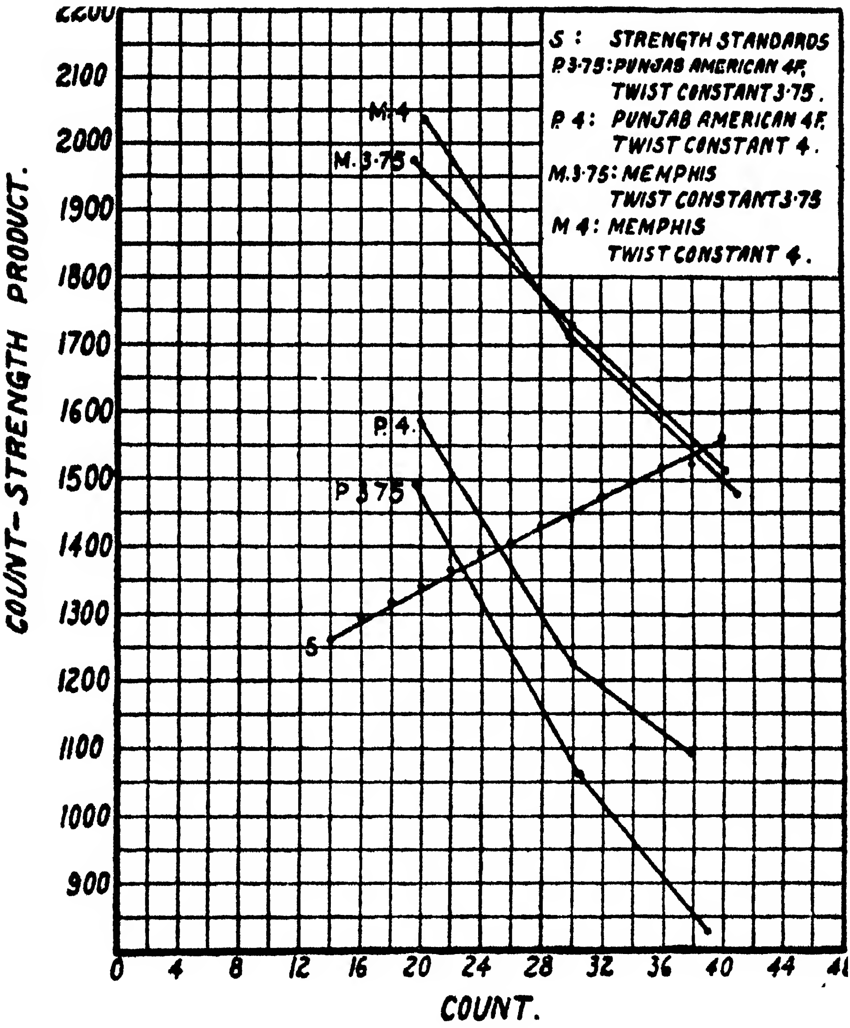

Fig. A. RELATION BETWEEN COUNTS AND COUNT-STRENGTH PRODUCTS

which indicates the highest count of standard warp yarn for which the cotton is suitable. Thus, in Fig. A (p. 309) curves are plotted for the results given above for the Punjab-American 4F and Memphis cottons; from the intersections of these curves with the curve of strength standards it is deduced that the highest counts of standard warp yarn are 22/24's for the Punjab-American 4F and 38's for the Memphis cotton.

From what has been stated above, it will be clear that an alternative scale might be adopted in which counts and strength varied inversely as one another, giving a constant value for the count strength product. The standard curve showing the relation between the counts and the count strength products becomes in this case a straight line parallel to the counts axis. For American yarns various rules have, in fact, been put forward embodying this principle, or slight modifications of it, but each of the different figures which have been suggested for the standard count strength product involves considerably higher strength standards than those of the above table. It should be noted that this method still entails that a cotton of better quality must be used for a finer count, although it does not differentiate so sharply between different cottons. So far as Indian cottons are concerned, however, the reason for making the scale increasingly severe with the rise in counts is a practical one. It has to be remembered that yarns are made to be used, and that what is important in weaving is the actual strength of the yarn in relation to the load it has to bear. In weaving, the individual yarns of a fine warp are, as a rule, relatively more strained than those of a coarse warp; they must therefore be relatively stronger, otherwise there would be an excessive number of warp breakages, detrimental alike to production and to quality. How much stronger the fine yarns must be is a question which is ultimately determined by the quality particulars of the cloth it is desired to weave, together with the relative prices of different qualities of the given counts of yarns. The particular strength values given in the above table of strength standards must therefore be regarded as to a certain extent arbitrary; they may, however, be taken as values which would be given by good qualities of Indian yarns of the respective counts.

In conclusion, it may again be emphasized that there is generally a limit to the fineness of count to which any given cotton can be spun by machinery. This limit is essentially an economic one; it is arrived at when the additional monetary return which can be obtained for the yarn of finer count spun from the same cotton is exceeded by the extra cost of producing that finer count, the extra

cost being due to a probably lessened production, additional yarn breakages, and more waste in the process of spinning—factors which also lead to discontent among the operatives. This upper limit of the spinning capacity of the cotton may be regarded as the limit of the cotton for weft yarns. But within this limit is the other limit relating to the use of the cotton for warp yarns; at the Technological Laboratory it is this limit which it is the function of the spinning test to determine as accurately as possible, and it is in the solution of this problem that the ascending scale adopted in the table of strength standards finds its application.

Spinning Technique.—An account may now be given of the detailed treatment of samples during the spinning test, with particular reference to small samples. Normally the cotton is passed through the lattice feeder, which feeds direct to the Crighton opener; the material is collected after passing through the Crighton, and is then passed through this machine a second time, being fed by hand. On again emerging from the Crighton the material is collected, and then fed by hand to the hopper feeder, from which it falls on to the feed lattice of the scutcher. It is at this point that one of the main difficulties in the treatment of small samples is encountered. With a small sample it is not possible to keep the hopper full throughout the whole or even the major portion of the operation, so that when the emerging cotton falls on to the scutcher lattice it gradually thins out as the amount of cotton in the hopper diminishes. In order to avoid irregularities from this cause, the cotton is evened out on the scutcher lattice by hand. It then passes through the scutcher, and the lap is formed. This lap is, of course, irregular at its two ends. With samples weighing 5 lbs. or less only two laps are made, each of which is unrolled and doubled on itself for the next scutching, giving the equivalent of four laps; with samples weighing 10 lbs. or more four separate laps are made direct. The four laps are then unrolled one above the other on the scutcher lattice, and again passed through the scutcher. This process is repeated once again, the three passages through the scutcher corresponding with treatment by opener, intermediate, and finisher scutchers. As a result of the method of treatment adopted, it is only the two ends of the finisher lap which are irregular. In the subsequent treatment the material of these end portions is carefully kept aside, and tests made only on the central portions, which alone represent the normal material as it would be obtained if the cotton were being treated in bulk. Special attention is given to this point in all the subsequent stages, so that the test bobbins finally obtained shall be truly representative of what would

be obtained with bulk spinning. The first and last portions of the sliver delivered by the card are rather below normal weight, and are therefore not used in the preparation of the rovings for the test bobbins; but in order to make the determinations of waste as accurate as possible, the rejected portions of sliver are passed through the subsequent machinery separately, and their weights included at each stage. It is the necessity for rejecting such portions of the material which in effect fixes the lower limit of the weight of the sample. It may be added that a 2-lbs. sample is the minimum which can be spun satisfactorily in the different counts—at any rate, with the present procedure. Even in this case it has occasionally been found impossible to avoid using in the preparation for the test bobbins some of the earlier portion of the card sliver which is rather below normal weight. Moreover, with a 2-lbs. sample it is only possible to spin four instead of ten test bobbins in each count. All things considered, therefore, the tests on these samples can hardly be regarded as so satisfactory in general as the tests on samples weighing 5 lbs. and upwards. Nevertheless, as will appear later in this note, it has not been found possible to justify this conclusion by reference to the actual results for the 2-lbs. samples herein reported on.

The normal procedure after carding the material is to pass it through two heads of drawing. The material is then passed through the slubbing, intermediate, and roving frames, and spun from single roving in the ring frame. For the better class cottons the drafts from the card onwards are so arranged that the draft in the ring frame for the yarn of 30's counts is about six. The practice hitherto has been to obtain different counts merely by changing the draft in the ring frame. While this expedient may not be entirely satisfactory, it has the practical advantage of saving much time in making changes on the preparatory machinery, with all the testing of wrappings which would otherwise be necessary. It is possible, therefore, that only the medium counts can be regarded as having been spun under the most favourable conditions. As the matter is one of some importance, it is being investigated for a number of standard cottons. The actual drafts which have been used, together with other ring frame particulars, are given in the tables relating to each sample reported on. From these particulars, various deductions about the spinning operation can readily be drawn if desired. Thus, from the front roller speed (column 10) and the roller diameter (column 11) it is a simple matter to calculate the theoretical production. In most cases the figures for actual production of the highest count spun are

also given, so that the spinning efficiency for this count (where the spinning efficiency is likely to be least) can readily be calculated. The figures for card production give some idea of the conditions of working of this machine. The "ring frame turns per inch" (column 13), taken with the counts (column 3), show the type of yarn which was being spun.

Waste.—Figures are given for each lot of cotton tested to show the percentage waste made at each stage. The wastiness of a cotton is, of course, a very important matter, because the waste represents an economic loss, even although part of it may be used in mixings for lower counts. There is no doubt that the wastiness of a cotton depends on many factors: some are derived from the characters of the cotton plant, these in turn being derived from hereditary or environmental factors operating during growth; some may be derived from the machinery used in treating the material; and others from the human element. In these reports it is impossible to separate the effects of these various factors; but from the known origin of each of the cottons it may be taken as a general rule that for any given sample the waste made is not greater, and is in many cases probably less, than would be obtained from the commercial crop of the particular cotton.

In the spinning tests, great care is taken at all stages to recover the waste immediately after each lot of cotton has been put through. The waste made at each machine is weighed separately on a delicate Avery mint balance of maximum load 50 lbs. and turning by 5 grains. With small samples, the cleaning operations for many of the machines takes up considerably more time than the actual processing of the cotton. The carding engine may be cited as an example; it may take about ten minutes to effect the carding of a 2-lbs. sample, but another half an hour's running will be necessary before flat strips cease to be produced, and a further twenty minutes are then necessary for cleaning. In the present reports the wastes are shown simply as totals for blow room, card room, and spinning room respectively, with the total loss given separately. It should be noted that ordinary mill practice is followed in the recording of these losses; for instance, the percentage "card room loss" (column 6) represents the total loss in the card and other preparation machinery reckoned as a percentage of the weight of the laps received from the blow room. The total cotton losses sustained in the complete spinning tests are also reported (column 8), being given as percentages, based, of course, on the original weights of the samples.

Speed Anomaly.—Lastly, with reference to the spinning operation,

it may be remarked that when a given cotton has been spun into a single count with more than one degree of twist, the stronger yarn (that with the higher twist) has actually been spun at a slower speed, as shown by the front roller speed, than the yarn spun with the lower twist. This would be avoided, if possible, in general practice, and the stronger yarn spun at the higher speed. But to obtain a higher twist a smaller twist wheel is necessary, and this entails a *slower* front roller speed; the only method of compensating for this is to speed up the whole machine. This was not possible in the tests herein reported on because, although the ring frame on which the yarns were spun is driven by a variable speed motor, the maximum speed possible had already been used in the spinning of the yarn with the lower twist. It is intended to correct this by using a larger motor pulley, which will enable a higher maximum speed to be attained; the yarn with lower twist will then be spun at a lower motor speed, leaving the higher motor speeds available for the higher twists.

III. Fibre Tests.

As already indicated, there is no doubt that the fibre properties are related in some way to the performance of the cotton in the spinning test. The investigation of what exactly this relationship is forms another branch of the activities of the Technological Laboratory. The fibre tests herein reported on comprise:

(1) Mean fibre length;
(2) Fibre length distribution;
(3) Mean ribbon width;
(4) Mean convolutions.

Other features which will be included in future reports are:

(5) Mean fibre weight per inch;
(6) Mean fibre strength.

Fibre Length.—In the determination of fibre length it has to be remembered that a sample of even a pure strain cotton contains fibres of many different lengths. It is possible to determine the mean fibre length by means of two different instruments, the Balls sorter and the Baer sorter; the results from these two instruments serve as mutual checks upon each other. Four determinations are made with the Balls sorter and eight with the Baer sorter. The tests on the Balls sorter also serve to show the fibre length distribution, which,

indeed, has to be determined before the mean fibre length can be ascertained. The fibre length distribution is also shown graphically for each cotton. These graphs (Figs. 1-18 in full report) show at a glance the percentage of short fibre present and the regularity of the cotton.

Ribbon Width.—The mean ribbon width is obtained from measurements under the microscope of fifty different fibres. Each measurement is made of the ribbon width practically midway between a pair of convolutions, as it is at this point only that the full ribbon width is seen under the microscope; ten observations are made on each fibre, and the mean taken of the whole 500 observations.

Convolutions.—The number of convolutions or natural twists in the cotton fibre is also obtained from measurements under the microscope, the total number of convolutions being determined for each of fifty fibres, and the mean taken. In these reports a convolution is regarded as being due to the twisting of the fibre on its longitudinal axis through an angle of 180 degrees.

IV. Yarn Tests.

It was pointed out in the Introduction that the intrinsic value of a cotton comprises three factors—viz., the quality of yarn spinnable from the cotton, its behaviour in spinning, and its wastiness. The property of wastiness has already been discussed (p. 313). The behaviour in spinning is an important feature, to which the quality of the yarn produced is but an imperfect guide, even if it can be taken as a guide at all. The behaviour in spinning is, however, shown fairly well by the number of yarn breakages per ounce of yarn spun, a feature which is accordingly included in these reports; this is supplemented by the Spinning Master's report on the cotton.

In order to determine the quality of yarn spinnable from a cotton, it is first of all necessary to spin it, as already described on p. 311 *et seq.* The quality of the spun yarn has then to be determined in terms of its various properties. Some yarn properties significant of quality—viz., counts, lea strength, single thread strength and extension, twist—admit of numerical expression, but others do not, and for these—viz., colour and evenness (levelness)—it is still necessary to retain more or less qualitative expressions.

The various yarn tests are carried out in a standard manner as follows:

(1) Counts actual: Determined on an Avery yarn balance by weighing the individual leas used in the lea strength tests after these tests have been carried out.

(2) Lea strength: Determined on the Goodbrand lea tester No. 18, maximum load 150 lbs., electrically driven.

(3) Single thread strength
(4) Single thread extension
$\left.\right\}$ Determined on 12-inch lengths in the Goodbrand single thread tester No. 20, maximum load 16–64 ozs.

(5) Twist (turns per inch): Determined on the Baer twist tester No. 17 on ½-inch lengths, or on the Goodbrand twist tester No. 2 on 1-inch lengths.

The rate of traverse of the lower grip in both the strength testing machines is 12 inches per minute.

It is hoped to include in future reports the results of: (6) Ballistic tests.

Sampling.—With reference to the yarn testing, it may be explained that the normal practice in the Technological Laboratory is to make all the tests on the test bobbins referred to earlier in this note. As 10 bobbins are normally available for each count of each lot of cotton, the yarn from each bobbin is used for 5 tests for count and lea strength, 25 tests for single thread strength and extension, and 20 tests for twist. A careful analysis of the results for some of the earlier tests indicated that the strength and twist tests on the single thread might be reduced in number without appreciable error, and for later samples (No. 74 and after) 20 tests were made on each bobbin for single thread strength and extension, and 16 tests for twist. The figures given in the various reports for any one count of any one lot of cotton therefore represent the mean values for the 10 bobbins—*i.e.*, 50 tests for count and lea strength, 250 (or 200) tests for single thread strength and extension, and 200 (or 160) tests for twist. When the lots are only 2 lbs. each in weight, it is possible to spin only 4 bobbins of each count, and in this case the yarn from each bobbin is used for 5 tests for count and lea strength, 50 tests for single thread strength and extension, and 50 (or 40) tests for twist, making in all 20 tests for count and lea strength, 200 tests for single thread strength and extension, and 200 (or 160) tests for twist.

Lea Tests.—The most important tests are those for count and lea strength. These are the tests which are generally carried out, together with the yarn examination on blackboards, as a matter of

routine in ordinary mill practice. In spite of its many acknowledged defects, the lea strength test is probably the most satisfactory test for strength, because the sampling error is so much less in this test than in the single thread tests. Thus in 50 lea tests 72 times as much yarn is tested as in 250 single thread tests: it is evident, therefore, that the unavoidable errors due to faulty sampling are much less likely in the former case than in the latter. Where, therefore, the lea tests and the single thread tests appear to be contradictory, it is most probably due to this sampling error, and in this case greater credence must ordinarily be given to the results for the lea tests. But before this is done it is necessary to examine the results to see whether any alternative explanation is possible. For instance, where a regular yarn is being compared with an irregular yarn, it is to be expected that the ratio of the lea strength to the single thread strength will be greater for the regular yarn than it will be for the irregular yarn. The figures given for the irregularity of single thread strength will serve to indicate whether this particular factor is operative.

There is no doubt that, theoretically, the lea test is not entirely satisfactory—first, because it affords no trustworthy guide to the extension of the yarn; and, secondly, because in the subsequent stages of manufacture the yarn is seldom treated in the form of a lea or hank, the only noteworthy exceptions being hank sizing, hank bleaching, hank mercerizing, and hank dyeing. In other operations —winding, warping, and weaving—the yarns are so stressed and strained that the breakage of a single thread leaves the other threads practically unaffected. But in the lea test one continuous length of yarn is being tested, and the breakage of a single thread greatly affects the portions of the yarn near the place of breaking, so that, when the lea has broken in only a few places, it cannot withstand any further increase in load. It appears to follow, therefore, that the lea strength test cannot be a complete guide to the behaviour of the yarn in the processes of winding, warping, and weaving. For these reasons the single thread test, which yields a value for single thread extension as well as for single thread strength, has been retained for the routine examination of the spun yarn, in spite of the much greater chance of sampling error in this test. Some idea of the sampling error possible may be gathered from the fact that on a bobbin containing, say, 1½ ozs. of 20's yarn there is a total length of yarn of about 1,500 yards; of this, therefore, some 600 yards are actually tested in the 5 lea tests, less than 7 yards in the 20 single thread tests, and from only ½ to ¼ yard in the twist

tests (according as the twist tests are made on 1-inch or ½-inch lengths). The exigencies of the case make it necessary to test consecutive lengths in the lea and single thread tests. This is comparatively unimportant in the lea test, as the total quantity of yarn tested is a large proportion of the whole, and serious error will only ensue if the yarn on the top half of the bobbin differs appreciably from that on the bottom half. But it is quite another matter with the single thread tests, for it is most unlikely that any one 7-yards length will be truly representative of all other 7-yards lengths in the 1,500 yards, so that, although within any particular 7-yards length the variation may be small, as between one 7-yards length and another the variation may be considerable. An investigation is now in progress to ascertain, if possible, what may be regarded as a normal variation of the latter type.

Irregularity.—The variation which occurs in all the individual results obtained in the determination of any property is a matter of some importance, and is indicated by the irregularity. The irregularity of any set of observations is calculated by subtracting from the mean the average of all those results which are less than the mean, and then dividing this difference by the value of the mean. The fraction thus obtained is usually multiplied by 100 to express the irregularity as a percentage. In the tables of spinning test results are included (1) the irregularity of the lea strength, as calculated from the 50 individual results, 5 from each of 10 bobbins; (2) the irregularity of the single thread strength, as calculated from the 250 (or 200) individual results, 25 (or 20) from each of 10 bobbins; and (3) the irregularity of the single thread extension. The irregularity derives its importance from the fact that what matters in the practical operations is not the average strength or the average extension so much as the number of places which are unusually weak or have unusually low extension, because it is these which are responsible for trouble by breakages. The irregularity is, therefore, to a certain extent a measure of the likelihood of breakages occurring. It suffers from the defect, however, that it is a statistical abstraction, so that its significance cannot be visualized. A new statistical measure has therefore been introduced in these reports which avoids this objection. The new measure has been termed the "Weakness Percentage"; it represents the percentage of the results for single thread strength which are less than three-quarters of the average strength. This is a quantity which can be visualized directly with reference to practical conditions of working. A similar statistical measure for the extension is no doubt at least equally important,

and it is proposed to adopt the expression "Low Extension Percentage" to express the percentage of results for extension which are lower than three-quarters of the average extension. There is reason to believe that the low extension percentage is correlated with the weakness percentage, so that the figures for the latter may suffice to express both; this matter is now under investigation. In the present reports, however, only the figures for "weakness percentage" are given.

Evenness.—The statistical expressions for irregularity are, however, only one way of regarding the question. Another important method in common use is to inspect the yarn when wound on to blackboards. For purposes of distinction, in the present test reports the term "Irregularity" is restricted to the statistical expressions, while the term "Evenness" is used to indicate the property as estimated by visual examination. The evenness is expressed by reference to one of the following five classes:

1. Very even.
2. Even.
3. Fairly even.
4. Uneven.
5. Very uneven.

Neppiness.—At the same time as the evenness is observed the opportunity is taken to observe the number of neps present in the yarn, as the presence or absence of neppiness constitutes a very important practical feature. For the purpose of the present reports, the number of neps has been counted in ten portions of yarn, each 3·6 inches long, taken from each of four bobbins; the neppiness is expressed as the average number of neps per yard of yarn. These features are included in the "Yarn Examination Report."

V. Grader's Report, etc.

In addition to the fibre test results (with the graphs relating to them) and the spinning test results (including the Spinning Master's report on the cotton and the yarn examination report), there are included the grader's report on the samples, and, as far as possible, an indication of the size of the crop of the standard cotton in question. It will no doubt be found of interest to compare the grader's reports with the results obtained for the cottons in the fibre and spinning tests, while the size of the crop has, of course, an important practical interest.

VI. Physical Conditions.

Most of the important features presented by these spinning test reports have now been discussed. There remains, however, one noteworthy exception—the physical conditions of temperature and humidity prevailing during the spinning process and during the testing. In the attached reports figures are given to show the average temperature and relative humidity prevailing during the actual spinning operation on the ring frame, and also the average relative humidity prevailing during the tests for counts, lea strength, single thread strength and extension. Some difficulty has arisen in connection with the presentation of these figures. It would be preferable to give the temperature and relative humidity prevailing during each separate operation or test, but to do this would mean a very considerable expansion in the size of each table. Complete records of these physical conditions are, in fact, maintained, and it is believed that the figures published in these tables give at least a good indication of the conditions under which the spinning and testing have been carried out, and that no serious misconceptions as to these conditions or as to the qualities of the cottons will be caused by confining the reports to these average figures only.

VII. Presentation of Results.

For the first season in which any given cotton was tested a whole bale of it was obtained, and this was used, as previously stated, for spinning tests in a number of different lots. For the subsequent season duplicate tests have been made on 10-lbs. lots only. In order to facilitate comparisons in the tables, the results for yarns which are nominally similar but spun from different lots have been arranged one below the other. For example, in Table 1, instead of putting together all the results for the three types of yarn from the 100-lbs. lot, then all the results for the yarns from the 10-lbs. lot, and so on, the plan has been adopted of putting all the results of 20's counts of the various lots with 16·85 turns per inch, then all the results for 30's counts with 21·86 turns per inch, and finally all the results for 40's counts with 26·97 turns per inch. By this means it is a simple matter to compare the tests on the different lots for each count in turn. The wastes are entered only for the 20's (or 10's) counts; but as the same rovings are used for all three counts normally spun from any lot, it follows, of course, that the losses recorded for the main sources of waste—the blow room and card room—apply to all the counts: the figures for "spinning loss" actually refer to

the total spinning loss for all the counts of the particular lot under consideration.

The present reports include those on the cottons Surat 1027 A.L.F. (Sample No. 1), Coimbatore Co. 1 (Sample No. 2), and Punjab-American 285F (Sample No. 3), which were published in a preliminary note (April, 1925). In incorporating these earlier reports, the opportunity has been taken to add some further particulars in accordance with the requirements of the present form. As the machinery was new when these early samples were tested, and the present routine had not then been developed, further tests on these cottons were made at a later date (Sample Nos. 104, 105, and 106). The results for these and for the earlier samples are given together in the various tables.

In order to show in brief compass how the various standard cottons compare with one another, a summary table has been prepared (Table 19) showing the results for the 10-lbs. samples only, spun into the standard counts—20's or 10's according to the cotton—with standard twist. Where two 10-lbs. samples have been spun (*i.e.*, in the second and third seasons of testing any cotton), the practice has been followed of giving the results for one of them only—viz., that for which the spindles used have been the same as for the single 10-lbs. sample of the first year with which they are compared. Another point of special importance is that as the card waste for the earlier samples was deemed to be excessive, the necessary pulleys and change wheels were obtained for slowing down the main cylinder and the flats; these changes were made after the tests on the Texas American cotton (Sample No. 56), the main cylinder speed being reduced from 190 to 160 r.p.m., and the speed of the flats from 4 to 3 inches per minute.

VIII. General Discussion of Results.

Any special features relating to individual cottons are noted in the separate reports. The following remarks are therefore restricted to the more general aspects which these tests present. In the first place, reference may be made to the fact that in a number of cases the actual twist differs from the nominal twist. These differences may be accounted for by various reasons, chief among which are—first, that only a very small proportion of the yarn is actually used in the twist tests; and, secondly, that a considerable personal element enters into these tests, due more particularly to the difficulty of deciding the exact point at which twist has been removed. These difficulties give rise to the question as to whether it is worth while making

twist tests on single yarns. The tests are, however, being continued for the present, while an alternative method is being investigated.

As previously indicated, the chief reason for making tests on different weights of samples was to determine the trustworthiness or otherwise of tests on small samples. A study of the results now presented shows that trustworthy results can, in fact, be obtained from samples as small as 5 lbs. or even 2 lbs. in weight. Reference to the spinning test results will show that, taken as a whole, much the same results have been obtained for any given type of yarn from each of the weights of sample. This is true both as regards the yarn test results and the breakages sustained in the ring frame. The smallness of the figures for the latter, taken in conjunction with the other spinning particulars, shows that all the yarns have been spun in accordance with the requirements of economical spinning.

Card Waste.—Practically the only divergence of a general nature between the results for the different weights is to be found in the waste percentages, particularly in the card room loss. This is not unexpected, because the cotton required to "load" the card wire is recovered as waste when the card is cleaned, and this naturally forms a larger percentage the smaller the sample being treated. This is brought out in the table below, which shows for each of the various standard cottons the differences between the card room loss for a sample of 100 lbs. weight and the losses for the samples of the other weights.

TABLE SHOWING EXCESS CARD ROOM LOSS FOR SAMPLES OF VARIOUS WEIGHTS OVER THE LOSS SUSTAINED BY A SAMPLE OF 100 LBS. WEIGHT.

Sample No.	*Cotton.*	*Weights of Samples (Lbs.).*				
		(10)	5 (1)	5 (2)	2 (1)	2 (2)
62	Dharwar No. 1	1·3	2·2	2·1	4·2	4·2
70	Gadag No. 1	0·2	2·0	1·5	2·7	3·1
104	1027 A.L.F.	1·4	—	—	—	—
81	P.A. 4F	1·8	3·9	3·6	7·2	7·3
3	P.A. 285F	0·3	1·4	1·7	2·9	2·9
80	P.A. 289F	0·9	2·3	2·0	4·5	5·8
79	K. 22	0·7	2·3	3·0	5·1	5·9
77	C.A. 9	0·7	2·4	2·1	3·5	3·8
78	J.N. 1	1·5	1·2	1·4	6·0	6·5
22	A. 19	1·0	1·5	1·3	4·1	4·2
105	Co. 1	0·1	—	—	—	—
73	Nandyal 14	1·8	2·1	2·6	3·7	5·1
75	Hagari 25	1·6	2·1	2·9	4·5	5·2
6	Karunganni	—	1·6	1·8	3·9	4·7
82	Umri Bani	0·8	2·7	2·6	5·7	6·6
55	Mississippi	—	—	—	—	—
56	Texas	1·9	—	—	—	—

From the foregoing table we see that the average differences in the card room waste percentages are:

For the 10 lbs.	samples	:	0·9
,, 5 lbs. (1)	,,	:	2·1
,, 5 lbs. (2)	,,	:	2·2
,, 2 lbs. (1)	,,	:	4·5
,, 2 lbs. (2)	,,	:	5·0

It is important to observe that the actual difference for any given 10-lbs. sample is very near the average difference of 0·9; if, therefore, we subtract 0·9 (or say 1) from the card room waste percentage of a 10-lbs. sample, we shall obtain to a very close degree of approximation the card room waste percentage for a 100-lbs. sample—*i.e.*, for the cotton when treated in bulk. Except for the 4F cotton, the same may be said in a rather lesser degree of the 5-lbs. samples; in this case it is necessary to subtract 2 from the card room waste percentage in order to obtain the card room waste percentage for the cotton when treated in bulk. From the fact that all the differences for the 4F cotton are high, it is surmised that these are really due to an abnormally low value for the 100-lbs. sample. The variation between different 2-lbs. samples appears to be too high to permit of the use of a correction figure, especially as it would be about 5—nearly as high as the actual card room loss itself for many cottons.

It has already been remarked above that these differences may be taken as representing the cotton required to load the card wire. The significance of these figures is made rather more clear, therefore, if the differences are expressed in absolute weight instead of as percentages of the different weights of samples. If this is done, it is seen that the percentage differences—1 for the 10-lbs. samples, 2 for the 5-lbs. samples, 5 for the 2-lbs. samples—in each case represent the same absolute weight—viz., one-tenth of 1 lb., or say 1½ ozs. —*i.e.*, they all concur in indicating that 0·1 lb. of cotton is necessary to load the card. This is surprisingly good agreement in view of the fact that these figures have been deduced independently for the samples of different weights. Although this conclusion has reference only to the particular card on which the work was done, and to the particular settings used and the condition then existing, it appears that, in view of the long period over which these tests were carried out and the large number of different cottons concerned, the conclusion may have a more general application.

In connection with the action of the card may be mentioned one other point which serves to distinguish the 2-lbs. samples from those

of greater weight—viz., neppiness. Reference to the yarn examination reports will show that the yarn spun from the 2-lbs. samples almost invariably proved to be decidedly less neppy than that spun from larger samples. Observation of the card web during working has revealed the explanation of this feature: it is simply that the cleaned card is at first able to extract practically all the nep from the cotton which passes through it; the amount of nep appearing in the web then gradually increases to a maximum, which is reached when about 1½ lbs. of cotton has passed through. It is evident that due allowance for this fact must therefore be made in all spinning tests on small samples.

IX. General Conclusions.

Except for the card room waste and the neppiness, there is little difference between the results for the samples of different weight. The differences between the results for any one count spun from a number of lots of different weight are no more than often obtain for lots of the same weight. If, therefore, the spinning tests had been confined to tests in duplicate on lots weighing only 5 lbs. or 10 lbs. respectively, they would have led to accurate conclusions regarding the spinning capacity of the cotton. There are, of course, certain minor anomalies which are referred to in the remarks upon the individual cottons. But these anomalies would not of themselves have caused a wrong judgment to have been formed on any of the cottons (with one doubtful exception—Karunganni, Sample No. 107, Table 15A), because the method adopted of spinning each of the duplicate lots of the cotton into three different counts and then making various tests on the yarn provides so many cross-checks that discrepancies are normally revealed, and can be allowed for. It is therefore concluded that the procedure which has been adopted for testing small samples submitted by cotton breeders—viz., making spinning tests in duplicate on lots weighing only 5 lbs. each—is completely justified. Certainly there are now the strongest grounds for this conclusion, so far as it applies to the range of counts possible with Indian cottons—*i.e.*, up to 40's. Whether the conclusion can be extended to the utmost limits of fineness to which better class cottons can be spun is a matter which lies beyond the scope of the present series of tests.

AN ACCOUNT OF THE PROGRAMME OF WORK OF THE GENETICS DEPARTMENT, COTTON RESEARCH STATION, TRINIDAD

BY

S. C. HARLAND.

THE science of genetics deals with the way that characters are inherited in both plants and animals. It is only within the last thirty years that the laws of inheritance have been formulated, but an enormous body of information is being rapidly accumulated on the manner in which characters are inherited in such diverse material as fruit-flies, sheep, mosses, maize, barley, and snails. It has now been shown that although each species of plant or animal has its own special characters, the mode of inheritance of such characters is governed by the same laws. Thus the presence and absence of wax on the stem of the castor-oil plant is inherited in the same manner as the presence and absence of brown pigment in the eyes of human beings, or the presence and absence of red colour in the leaves of cotton. The general aim of genetic studies of the cotton plant is to identify the unit characters found in the genus as a whole, elucidate their mode of inheritance, and apply the knowledge thus gained in the synthesis of new and better varieties than those now grown. If it became necessary to produce a new American cotton with brown staple, red leaves, and yellow flowers, it could easily be done because we know the exact mode of inheritance of each of these characters. But if we were asked to produce a new variety of American cotton with staple exactly like that of Sakel Egyptian, we should have to confess that we do not at present even know whether it is possible. Most cotton-breeders declare that it is not possible to breed such a cotton, but reliable statistical evidence is lacking. It is thus necessary to define the limits to which the synthesis of new types possessing any desired combination of economic characters can be carried.

The genus Gossypium, to which cotton belongs, exists in an enormous number of varieties and species. Some of the species have only been seen in a wild state, and nothing is at present known of their agricultural behaviour or economic possibilities. There is a huge and practically unexplored field in the genus Gossypium which has never been exploited, and one of our first tasks was to get together

as complete a collection as possible of every species and variety of cotton from all over the world, and to begin an accurate study of their measurable characters, and of their taxonomic and genetic relationships. In this way the greatest possible advantage will be taken of the wide variability existing in the genus. Among the interesting types in our collection are: *G. tomentosum*, *G. Stocksii*, *G. Davidsonii*, and *G. Sturtii*, wild cottons from Polynesia. India, Lower California, and Australia respectively. We also have cottons from Turkestan, China, Burma, Nyasaland, New Guinea, Peru, Ecuador, and Guatemala, besides an exceptionally complete collection of commercial Upland, Sea Island, and Indian varieties.

Ordinary commercial varieties may be divided into two main groups: the New World group, comprising Upland, Sea Island, Egyptian, and Peruvian; and the Old World group, which include all the Indian types except the acclimatized Uplands, and some cottons from China, Korea, Japan, Burma, Afghanistan, and Africa. There is a great taxonomic gulf between these two groups, which represent the two fundamental divisions into which the genus Gossypium is divided. The New World cottons are capable of producing long and fine staple, and include the best of the commercial cottons. The Old World cottons usually produce short and coarse staple, which can be spun only into very low counts. They are, however, exceedingly hardy, and will grow under climatic conditions which New World cottons will not tolerate. They are said to be resistant to drought, and to certain insect pests such as the Pink Bollworm. Only their low yield and poor staple prevents them from replacing Upland cotton over large areas, and we are investigating the possibility of improving the yield by developing a large boll and the staple by hybridization. We have obtained certain types of Old World cotton from Upper Burma with exceptionally long and silky staple fully equal to good American. By crossing the Burma cotton with a heavy yielding type from China, known as the "Million Dollar" cotton, we have obtained some new long-staple Asiatic hybrids which have great merit, and which we hope will be ready for spinning tests in two years' time. Conceivably we may produce a new type of Old World cotton which may replace most of the American cotton in subtropical Africa. It should be mentioned that although hybridization is readily performed within the limits of each group, it is practically impossible to cross Old World with New World cottons, and even where successful the hybrids are completely sterile.

The breeding of disease-resistant cottons has also very great possibilities. Egyptian cotton in particular is very susceptible to

the Black Arm disease, which does a tremendous amount of damage in districts of high atmospheric humidity. Under the heavy rainfall of St. Vincent, some almost immune strains of Sea Island were isolated between 1915 and 1919, and these are being crossed with Egyptian varieties with the idea of building up a collection of resistant types for distribution in various parts of the world.

Although the work of the Department is primarily concerned with the purely scientific aspect of heredity in cotton, we consider that certain defects in commercial cottons can be partly eliminated, even with our present knowledge. An important problem is the cause and cure of neppy cotton. Certain types of Empire cotton are said to be neppy, and the same complaint is made about some Egyptian varieties. It is perhaps not too much to say that "neps" are one of the greatest sources of annoyance in the cotton trade, not only to the spinner but also to the finisher. All Egyptian varieties are not equally liable to produce neps: Sakel is said to be a neppy cotton, while the old Jannovitch cotton, now no longer grown in a pure state, was said to be particularly free from this defect. This indicates that the tendency to produce neps is partly an hereditary defect, and the way is thus opened to the elimination of one cause at least. We have made the interesting discovery that there are certain Mendelian factors which can cause the death of seeds inside the boll when they are partly developed, and when the lint on them, though of full length, has little or no secondary thickening. Cotton from these dead seeds produces neps when spun, and even if present to a small extent would give the spinner much trouble. We have established clearly that cottons differ very considerably in the proportion of dead seeds which they exhibit, some American-Egyptians showing 25 or 30 per cent., while selected types grown under proper environmental conditions are almost free from the serious defect. Aggregations of thin-walled hairs, collectively known as weak fibre, are, of course, also produced by bad environmental conditions, such as too much or too little water, or through the death of seeds by competition for nutrients, by insect attack, or by boll diseases. The breeding of American and Egyptian cottons free from an hereditary tendency to produce neps is not only important from the spinner's point of view, but is also agriculturally important because every dead seed is a loss also to the grower by reason of the diminution of the weight of the lint which it bears.

It is necessary to explain why studies of such seemingly unimportant characters as the colour of the flower or pollen are of value. It has been found that economic qualities are often associated or linked with minor structural features. Thus white-flowered beans are notoriously

more delicate than coloured varieties, and in cotton the colour of the flower or pollen may be linked with some deep-seated property of the staple, which is difficult to analyze by itself. We have observed that certain white-flowered rogues in Sea Island cotton are always characterized by shorter and coarser staple than the normal yellow-flowered type. Generally speaking, white flowers in a Sea Island crop are always borne on inferior plants, and should be eliminated wherever seen. There seems to be a linkage between pollen colour and boll loculus number—a character which bears on yield. Flower colour is probably linked with one of the factors for hairiness, and the latter character is important owing to its connection with resistance to jassids and aphides. As work proceeds, we hope to bring to light many more of these linkages.

There has been much discussion in cotton literature during recent years on the question of pure lines. We are of the opinion that with the possible exception of some of the St. Vincent and Montserrat Sea Islands, which have been self-fertilized for at least ten generations, no commercial cottons yet merit the name of pure line—*i.e.*, a strain in which all plants have identical hereditary factors. It is extremely difficult to demonstrate the purity of a strain, for it may be segregating in factors which are not capable of measurement. Some of the West Indian natives have never been observed to deviate from type, and as they have been naturally self-fertilized for probably fifty generations, it is probable that they are the purest known cottons. In the Sea Island cottons above mentioned rogue plants occur fairly frequently, and in such proportions that they cannot be regarded as ordinary Mendelian segregates, but are most probably mutations. We are now able to recognize the main types. One, the Crinkled Dwarf, was described by the writer in 1916, and shown to be a simple Mendelian recessive. It was not observed again till 1925, when it appeared in a pure line in St. Vincent. In 1927 it appeared as one plant in a two-acre field in a field of uniform Sea Island cotton in Trinidad. This type is certainly a mutation. Another type is the white-flowered type bearing poor staple. This is also a recessive mutant, as revealed by its behaviour when crossed with the normal type. Other rogues are characterized by sterility on either the male or female sides or both, but their relationship to the normal type is not yet known.

It is possible that the appearance of aberrant forms is due to the release of recessives from strong linkage by rare cross-overs, but it will be seen that it is important from an agricultural point of view to know whether it is really possible to get pure lines. If it is possible, the line will breed absolutely true for an infinite number of generations if

protected from natural crossing. But if, as we suspect, the tendency to produce rogue plants as recessive mutants with undesirable agricultural or industrial properties is a natural one, and inherent to the genus, it will become necessary constantly to renew the seed from a pure source, and to watch for the occurrence of inferior types. Otherwise the purest type may show serious degeneration in a few years. The whole question is being followed out in great detail, and it is hoped to review the situation at an early date.

On the purely scientific side, inheritance studies are being made of the following characters: colour of flower and pollen, petal spot, leaf colour and shape, male sterility, chlorophyll deficiencies, hairiness, seed-fuzz, and various lint characters. Particular attention is being paid to characters which are common to both the Old and New World groups. The former have thirteen pairs of chromosomes, while the latter have twenty-six pairs. On the hypothesis that hereditary factors, or genes, are located in the chromosomes, it is possible that comparative studies of inheritance in the two groups will afford some information on the method of evolution within the genus. So far we can say that the mode of inheritance of most characters seems to be much less complicated in the Old World cottons. Flower colour, for example, in this group appears to be conditioned by three pairs of factors, and the various shades of colour are comparatively easily distinguished. In the New World group we have so far identified one pair of factors with an unknown number of modifying genes tending to intensify or diminish the amount of colour in the flowers. Thus, while it is easy to classify segregating populations into yellow and cream, the colour gradations in the yellows are so subtle as to defy classification. Inheritance in New World cottons is usually complicated by modifying factors, and this is probably due to the greater number of chromosomes, which has in the past provided a greater opportunity for modificatory mutations to occur. Mutations appear to occur less frequently in Old World cottons, only one case having so far been recorded.

The cotton plant does not appear to differ from other plants in the way its characters are inherited, though Mendelian analysis is difficult. Considerable distortion of the usual Mendelian ratios often occurs, partly through the operation of lethal factors which kill certain zygotic combinations, and probably to some extent through differential pollen-tube growth. There is, however, every reason to believe that in a comparatively short time the mode of inheritance of many characters will be elucidated.

Received August, 1927.

WORK ON SOME PHYSIOLOGICAL PROBLEMS AT THE COTTON RESEARCH STATION, TRINIDAD*

BY

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The following is a short note indicating the work carried out by the Physiology Department at the Trinidad Research Station during the past year. Many of the problems that confront the cotton physiologist are such that to the non-technical reader it is not obvious that their ultimate bearing upon the successful growing of cotton is a very important one. Among so many, the selection of those which are both of great practical importance, and likely to yield results within a reasonably short time, is by no means easy; but, after careful consideration, it was decided that attention could most profitably be devoted to the following:

(1) The shedding of flower-buds and young bolls.

(2) Variations in form and development of the plant as a result of climatic and other causes.

(3) The condensation of sugar to form cellulose in the lint hair, thus thickening the hair into a definite fibre.

1. *Shedding.*—There is a very general impression that shedding is often responsible for a great loss of crop, and that the loss could be minimized if the causes were known. A great deal of work on shedding has already been done, but as yet only a limited amount of investigation has been carried out with a view to ascertaining what is happening inside the plant in periods preceding shedding. To make our meaning more clear, we will consider the shedding of flower buds and young bolls separately.

As regards the shedding of flower buds, cotton can, broadly speak-

* It is hoped that a paper giving full details of the work undertaken and the results obtained, of which this memorandum is but a summary, may be published shortly in the *Annals of Botany*. In that case reprints will be sent to members of the Corporation's staff abroad and to any readers of the Review who indicate their wish to receive a copy; requests should be received not later than the end of the year.

ing, be divided into two classes, the first characterized by the fact that if planted during the rains they continue to shed their flower buds until the advent of the dry season. It is still uncertain whether the change in relative length of day and night, and not the change from wet to dry conditions, may not be the causative factor. The native cottons of West Africa are generally of this type, and also the Serido cotton of Brazil and the Marie Galante cotton of the West Indies.

In the second type, to which belong American Upland and Sea Island, flowering is not normally postponed in this way, but begins at a definite period after planting, irrespective of the time of sowing; thus, in the West Indies, Sea Island cotton always flowers approximately eight weeks after planting.

The question arises as to what are the underlying causes responsible for these differences in the two types of cotton. The plant, as is well known, makes use of the energy provided by the sun's rays to manufacture sugars from the carbon dioxide in the air. This action takes place in the leaves, and the sugars are then distributed throughout the plant and provide 80 to 90 per cent. of the raw material out of which new tissues are formed. The growth of the roots, stem, and fruit depends, therefore, very largely on a continuous movement of sugar from the leaves to the other parts of the plant. It may be that in the first class of plants sugars manufactured in the leaf travel during the rainy season to regions where growth of leaves, stem, and roots is proceeding, and that the flower buds, unable to obtain the supply of sugar necessary for growth, are consequently shed. In any case it seems likely that the machinery of sugar transport is in some way involved. It is possible also that the absorption and movement of nitrogen in the plant may play an important part.

In the case of the young boll, shedding is often rampant in periods of wet weather. Generally speaking, a sudden change in humidity leads to a wave of shedding. The amount of shedding may also vary greatly from year to year. The causes of these phenomena are quite obscure, and little progress can be made in understanding them until much more is known about the factors determining the supply of sugar and nitrogen to growing organs. Again, all types of cotton, more especially those evolved in a dry climate, tend to "run to bush" in wet weather, vegetative growth proceeding at the expense of the reproductive centres. The mechanism by which food materials are thus diverted from reproductive centres to vegetative centres is clearly part of the general problem of translocation.

2. *Variations in Form and Development.*—As an illustration of this problem, we may consider the root development of American cotton in Southern Nigeria. For more than twenty years attempts to introduce this type of cotton have proved abortive, and have at last been discontinued, work now being concentrated upon the improvement of the staple of one of the native varieties. Now there is little doubt that the failure of the American type was very largely due to the fact that its root system is poorly developed as compared with the native type, for cotton in Southern Nigeria is grown among yams, maize, etc., and has consequently to compete with other crops for soil nutrients. There is, moreover, little doubt that the meagre development of the root system in American cotton is correlated with its habit of early flowering* and the way in which it produces its crop in a comparatively short period. In addition, there is some danger that if the native type at present being evolved flowers early and rapidly like the American, it too will be agriculturally unsatisfactory. The question is, why should early and rapid flowering be correlated with a poor development of the root system? This problem, like that of "running to bush" cannot, we believe, be profitably attacked until more is known about the fundamental laws governing the transport about the plant of nutritive substances, especially sugar and nitrogen compounds.

3. *The Condensation of Sugar to form Cellulose in the Lint Hair.*—A number of questions arise here. What, for instance, are the causes that prevent the deposition of cellulose upon the wall, which normally goes on in the lint hair, and thickens it into a real fibre? The importance of this question lies in the fact that the unthickened hair is extremely liable to give rise to a nep. The cellulose of the wall is formed from the sugar that is brought from elsewhere in the plant, and may roughly be regarded as merely a condensed form of sugar. The amount of thickening that can go on will thus be ultimately determined by the supply of sugar to the boll. Or, again, consider the great seasonal variation in ginning percentage. What is it that decides how sugar is apportioned between the seed and the seed hair? for it is this that really determines ginning percentage. These questions are thus again parts of the general problem of the transport of sugar about the plant, and the causes that determine how it is allotted to different parts of the plant and of the boll.

* It is of interest to note that types of cotton that flower very rapidly apparently attract cotton stainers to a greater extent than those that flower more leisurely.

All these special problems that we have been considering, therefore, thus depend for their proper solution upon an elucidation of the wider underlying problem of the transport of nutritive substances about the plant, and their local distribution to the leaves, roots, flowers, seeds, lint hairs, and other parts of which it is made up. It seemed to us, therefore, that an attempt to deal with this general problem was the most hopeful line of attack upon the others already mentioned which are of such great practical importance to growers and users of cotton.

About this general problem, although one of the first importance, comparatively little is at present known, and the difficulties in the way of a solution are considerable. Even a question so apparently simple as whether the main channel of transport in the stem is located in the wood or in the bark is still a matter of some uncertainty. We therefore set to work to find out a little more regarding the machinery by which sugar is transferred from one part of the plant to another, and the factors determining the rate and direction of movement.

Methods.—A strain of Sea Island cotton was used in our experiments, and sowings were made at fortnightly intervals, so that within limits plants of any desired size or age should be available for experiment at any time. The work consisted essentially in the analysis of samples of leaves, stems, and bolls collected at specified times from plants treated in certain definite ways. An important feature of the work was the determination of the concentration of sugar existing in the sap of the various tissues, as well as of the total amount of carbohydrate present. For this purpose a large fraction of each sample was frozen for twenty-four hours, and the sap, after thawing, then expressed by means of a powerful vice. In view of the importance of deciding between the alternative channels of transport in the stem—the bark and the wood—the bark was in all cases stripped from the wood and the two tissues analysed separately. The methods employed in sampling and in analyses are necessarily somewhat technical, and will not be considered here.

Diurnal Variations in Sugar Content.—The first series of observations consisted in analyses of sugar and of reserve carbohydrates in samples of leaves, bark, and wood collected every two hours over a period of twenty-four hours. It was found that in the leaf both sugar and reserve carbohydrates (mainly starch) fluctuate markedly, rising during the day and diminishing during the night. In the bark there are well-marked changes in total sugar concentration which follow closely on those in the leaf, with a " lag " of about two hours. This change in sugar concentration is not, however, accompanied

by any appreciable change in the reserve carbohydrates of the bark. In the wood no appreciable diurnal fluctuation is shown either by the total sugar concentration or by the reserve carbohydrates.

Observations were then made every three hours over a period of thirty-six hours and gave similar results. In this second experiment bolls were treated as well as leaf, bark, and wood. The diurnal changes in sugar concentration in the boll were on the whole similar to those in the bark; the sugar concentration rose during the day periods and fell during the night, both rise and fall being about three hours later than the corresponding rise and fall in the leaves.

The general picture of sugar transport suggested by these observations is as follows. During the day, as a result of carbon assimilation, the sugar concentration in the leaf rises and causes an increase in the rate of export of sugar from the leaf to the neighbouring bark. In consequence there is a rise in concentration in the bark; this rise spreads by a process analogous to diffusion, though differing enormously in rate, to the bark of the main stem and thence to the roots, bolls, and other growing points.

There is, however, an alternative picture of sugar transport by which the facts can be explained. In this second picture the channel of transport is provided by a narrow zone in the outer region of the wood, through which a mass movement of sugar in solution takes place as a result of differences in tension of water in different regions of the stem. A series of experiments specially directed towards the problem of the channel of transport was accordingly carried out.

The Channel of Transport.—The first experiment was a study of the effect upon sugar concentration in bark and wood of interrupting the continuity of the bark tissues. The plants used were 3 to 4 feet high, and the stem for about 18 inches from the ground level was trimmed of leaves and branches. About midway in this region of the stem a ring of bark ½ inch wide was removed from half the plants. Subsequent collections of ringed and normal plants at intervals of 6 hours enabled us to follow the course of events consequent on this interruption of the bark. The effect of ringing was very marked. Above the ring the sugar concentration in the stem tissues rose rapidly above that in the same region of the unringed plants; below the ring the sugar concentration fell as rapidly below the normal concentration. The leaves 2 feet above the ring showed a rise in sugar concentration quite as well marked as the rise in the stem tissues just above the ring. These results are clearly what might be expected if transport occurs in the bark, and differences

in concentration between different regions determine the rate of transport. The theory that transport takes place in the wood is not, however, necessarily excluded, since it is impossible to be certain that in removing the bark we are not interfering with the normal functioning of the wood. It has, in fact, been suggested that the function of the inner layers of the bark is to remove from the wood substances which might otherwise block the channels of transport. If this were true, complete contact between wood and bark would be essential for transport. We found, however, in an experiment designed to test this possibility, that sugar continues to pass down a stem through a region in which bark and wood are separated from one another by a ring of paraffined paper.

Finally, we were able to show that sugar will move downwards into a 7-inch flap of bark which is continuous with the bark of the stem at its upper end, but is separated from the wood throughout the whole of its length. The rate at which movement of sugar took place in this case was only a little below the rate of movement into the corresponding region of bark on the normal plant.

Having thus established that the bark forms the main channel of longitudinal transport, it was possible to explore further the accuracy of the general picture of transport suggested in the first instance by the results of the two diurnal series of observations, and to turn our attention to the movement of sugar from bark to boll.

The Growth of the Boll by Day and Night.—In studying the diurnal changes in sugar concentration in leaf and bark we found that sugar concentration in the bark is higher during the day than during the night. We should in general expect, therefore, that the rate of transport of sugar from the bark to the boll would also be greater during the day, and since at least 90 per cent. of the dry weight of the boll is derived from sugar, we might expect that the growth of the boll in dry weight should also be greater by day than by night. This possibility was tested by determining at 12-hour intervals the dry weights of large samples of bolls. The results showed a very striking difference between day and night growth, the average increment during the day being more than four times as great as the average increment during the night. The fact that the supply of sugar to the boll may be very much greater by day than by night is also of importance in connection with the phenomena of thickening of the cotton hair.

To return to the question of shedding, it has been suggested, for instance, that the shedding of young bolls, following a period of rain, may be due to a check in the supply of organic food to the boll as

a result of the diminished carbon assimilation of the leaves in cloudy weather. The present results suggest that a reduced head of sugar in the leaf may, in fact, very rapidly result in a reduced rate of sugar supply to the boll. Whether all cottons are alike in this respect is not known.

Reverting to the more general problem of movement of sugar along the bark, several lines of work were followed in the attempt to establish whether the analogy with diffusion did indeed provide a sound basis for the interpretation of the phenomena. On the diffusion analogy reversal of the direction of movement is merely a question of reversing the relative position of source and "sink." We were able to establish the fact that sugar will move into the middle region of a stem either upwards or downwards, and some evidence was also obtained that the leaf, normally an exporter of sugar, could be made to import sugar.

The analogy with diffusion was also tested by experiments in which fractions of bark were removed. When a partial ring of bark is removed, leaving a strip or a "bridge" of bark intact, it is found that the total amount of sugar passing the constriction in a given time is diminished, but not in proportion to the width of the amount cut away. For as a result of the partial block the sugar concentration above the "bridge" increases, while that below the "bridge" decreases, so that the gradient across the "bridge" becomes steeper, and the rate of flow across unit cross-sectional area of the strip increases. Evidence accumulated in this way strongly confirms the suggested relation between gradient in sugar concentration and rate of movement of sugar.

To sum up the results so far obtained: While the problem of the exact nature of the mechanism responsible for the high rate of sugar transport is still unsolved, the channel of transport has been proved to be the bark, and some of the factors responsible for alterations in the rate and direction of movement have been identified. It is clear, however, that this problem of transport of sugar is both complex and difficult, but upon its proper solution depends the elucidation of the apparently simple problems of shedding, etc., with which we started.

Received August, 1927.

CO-OPERATION IN SOUTH AFRICA

BY

T. G. HESSE.

While the primary object of the co-operative movement is to conduct the business of its members for their greatest mutual advantage, it has also to contribute to the solving of problems confronting the agricultural industry, and to meet questions arising from the world-wide social and economic unrest. The co-operative movement amongst cotton growers in South Africa has been closely identified with the cotton-growing industry from its earliest days, and has been of very considerable influence on the course of development which the industry has taken.

We trace the present era of cotton growing to about 1910, when the Government in the Transvaal undertook experimental work with cotton, and encouraged farmers to take up the crop. Progress during the first few years was very slow; little by little, however, cotton obtained a firmer footing, particularly in the Rustenburg area, where most of the Government experiments were carried out. But the crop was still so small that there was no inducement for private enterprise to enter the field as ginners and buyers, and therefore the growers found that besides proving cotton as a suitable crop they also had themselves to undertake the ginning and marketing. They undertook this task co-operatively, and the "Rustenburg Boeren Ko-Operatieve Vereniging," already in existence in Rustenburg handling the agricultural produce of its members, was the first to take up cotton and to erect a small ginnery. Gradually cotton growing also took a firm footing in Natal, and "The South-African Co-operative Cotton Growers, Ltd." was formed to handle the cotton there produced. At about the same time a number of growers in Barberton formed the "Barberton Cotton Co-operative Company, Ltd.," and in a modest way started their ginnery, which has now grown to a complete outfit. The appearance of the first private ginnery, established in a small way by Messrs. John Jack, Ltd., in Pretoria, also took place in this early period of expansion, but the pioneer work had been done by co-operative action of the growers themselves.

The slump in the cotton market of 1920 was a very cruel blow. Members delivered their cotton during the first half of the year while prices were still at the peak, and before the crop after ginning could be moved to overseas markets the price had dropped disastrously, causing severe losses to all concerned. Nevertheless, cotton growing continued to expand, and the co-operative movement with it. As cotton found favour with farmers in different districts, so were co-operative societies formed in these areas. As soon as the outlook was sufficiently promising, private enterprise invaded the field of ginning, so that co-operative effort has been subject to severe competition. This, of course, is all to the good, as it forces all parties to keep to a high level of efficiency.

Co-operation, then, came into existence to fulfil a definite economic requirement, and the strength and growth of the movement is built upon the sound foundation of response to the economic requirements of cotton growers. It is computed that the majority of growers are members of co-operative societies, but no reliable census of growers is available. This preponderance, however, does not exist as far as control of output is concerned, mainly owing to the existence of large non-co-operating estates, whose production is equivalent to that of hundreds of individual farmers.

Organization.—Co-operation in the Union of South Africa is governed by the provisions of the Co-operative Societies Act No. 28 of 1922. Co-operative societies fall into two main categories—namely, first, societies the members of which accept joint and unlimited liability for the commitments of their society; and, second, societies in which the liability of members is limited to the amount of share capital subscribed by each member. At present the general preference of farmers is for the latter. A further division may be made into societies dealing with cotton only, and societies dealing with other products as well.

Membership.—Membership in all societies is restricted to *bona fide* farmers. In order to hold a co-operative organization together, and to allow it to embark on such an undertaking as the erection of a ginnery, it is, of course, necessary that members bind themselves to active support. On assuming membership a grower, therefore, specifically undertakes to deliver all cotton produced to the company. This obligation is assumed for the incorporated life of the association, but a member has the right to withdraw at the end of any financial year, provided he shall have given notice in advance of his intention to do so. As far as voting power is concerned the democratic principle of "one man one vote" applies, irrespective of

whether the member's contribution of business or of capital be large or small.

Finances.—The capital required by associations is of two kinds: what may be termed a "permanent" capital for such purposes as the erection of a ginnery, and a "seasonal" working capital from which to make advances to members pending sale of the cotton, and from which to meet running expenses. Practically all associations obtain their capital requirements from the Land and Agricultural Bank of South Africa, a semi-Government institution, in the shape of loans, usually at a charge of 6 per cent. interest. Loans for permanent works must be repaid by annual instalments spread over a number of years, while seasonal loans for advances, etc., must be liquidated during the season. The security against which these loans are given is formed, in the case of societies with unlimited liability, by the credit of the membership, which becomes severally and jointly responsible; and in the case of limited liability societies by the amount of share capital subscribed by members. In addition to this security the Bank also holds a lien on the property of the company, and often requires a contingent liability to be assumed by the Directors. Of the share capital of the limited liability societies, as a rule only 10 per cent. is paid up, and it is the aim of the societies not to make further calls on the members, but to repay loans out of ginning revenue.

Management.—The direction of affairs of each society is vested in a Board of Directors and a manager selected by them. The Directors are the legal representatives of the association, and are responsible for its general welfare and the proper conduct of its affairs. They are elected annually and serve without remuneration, but receive travelling and subsistence allowances while attending to the business of the company. The Board appoints the officials of the company and determines the powers and the duties of the manager, which in the main are the same as in such positions in other business organizations.

METHODS AND POLICIES.—As already mentioned, members must deliver all cotton produced to the society, which then becomes responsible for the handling, ginning, and selling of the cotton.

Delivery.—Members deliver their seed cotton packed in woolpacks holding on an average 500 lbs., and immediately receive an advance of 60 per cent. of the company's valuation of the seed cotton.

Ginning.—The societies not owning a ginnery make contracts for the ginning of their members' cotton either with another co-operative ginnery or with a private ginnery, whichever is the most

conveniently situated or offers the most advantageous terms. Of course, such societies can obtain lower charges than the individual owing to the quantity of cotton controlled.

Five societies operate their own ginneries, all well-equipped, up-to-date plants, with high-density ginning compresses. The ginning charge is such as will cover the actual running charges plus interest and instalment due for repayment of capital. Co-operation being organized to render services and to operate for the mutual benefit of members, there is no intention to earn profits, so that the ginning is virtually done at cost. In practice this charge works out at about 1d. per lb. of lint. The severe competition between co-operative and private ginneries, of course, forces the ginning charge to the minimum possible, and co-operators claim that the co-operative ginneries have led the way in reducing charges, and that but for the existence of the co-operative ginneries the charges would still rule at a higher level.

The cost of ginning per unit of 1 lb. lint, of course, mainly depends upon the seasonal turnover. In a year of crop failure and consequent low turnover, therefore, a deficit may be revealed, while on the other hand a general increase in production would enable a further reduction of charges.

The charge of 1d. per lb. of lint or £2 per bale of 500 lbs. gross is considered as very reasonable in view of the services rendered. The seed cotton is delivered in woolpacks; these have to be weighed, sampled, and stored. Later they are taken from their stacks to the opening floor to be emptied. From that moment the ginning process is automatic, as all plants are fitted with suction feeders and battery condensers delivering the lint straight into the press fitted with automatic trampers. The empty woolpacks have to be sorted and despatched to the owners. The lint bales are sampled and one set of samples sent to the Government Grading Office, another to the Selling Office. The bales, high-density compressed and ready for export, are stored and after sale delivered to the buyers' order. The seed is bagged, stored, and likewise delivered to buyers' order. An elaborate system of accountancy is necessary to account to growers for the seed cotton received, the resulting lint and seed, the sale prices, proceeds, and charges.

Pooling.—While a few societies follow the practice of paying out to members the actual sale price of the cotton, less realization charges and commission, most follow the truer co-operative method of pooling and paying out to members the pool price. By operating seasonal pools, there is eliminated for the members the possibility

of loss or gain from sales made at the bottom or the top of the market.

All cotton of the same grade, staple, and colour goes into one pool. The number of pools depends, of course, on the class of the cotton received, and there may be as many as fifty or sixty pools, and a member may be participating in one or several. The pools are adjusted in such a way that each grower is assured of the average sale price of cotton for the season and of obtaining a premium for quality production. To illustrate, the experience of one society last season may be quoted. There were forty-two pools, and the average sale price for all cotton was 8·50d. The highest pool, Strict Good Middling, good colour, 1¼ ins., paid out 11·00d. The pool of Good Middling, good colour, 1⅛ ins., paid out 9·00d.; and the pool of Strict Middling, yellow spotted, 1⅛ ins., paid out 7·50d., and so on.

As previously mentioned, an advance of 60 per cent. of the value of the cotton is made to the grower as soon as the cotton is delivered. Further distributions are made from time to time during the season, when consistent with conservative management, as sales are made and cash accumulates. Final distribution is made at the end of the season.

Central Agency.—At an early date of the expansion of the co-operative movement, the need was felt for an overhead organization, to deal with matters too large for the local societies, to co-ordinate their activities, and to act as a National Sales Agency. This led to the formation of the Central Co-operative Cotton Exchange, Ltd., with its headquarters in Durban. At present the membership of this central agency consists of ten societies, including all the eight cotton co-operative societies in the Union, one in Swaziland and one in Northern Rhodesia. Five of these societies operate their own ginneries—namely, the Rustenburg Boeren, the Barberton, the Zululand, the Swaziland, and the Northern Rhodesia Societies.

Organization.—In its main points the organization of this central agency conforms to that of the individual societies, and is also governed by the provisions of the Co-operative Societies Act No. 28 of 1922. Membership is confined to co-operative societies, which means that the federal body cannot deal with individual farmers. Liability of members is confined to the amount of share capital subscribed by each. The management is in the hands of a Board of Directors to which each of the affiliated societies nominates its own member, who must at the same time be a Director of the nominating society. From the Board a Chairman and Vice-Chairman are elected, and here also the democratic principle of one vote to each member, irrespective

of the business handled, is in force. The Board of Directors appoints the officials to be in charge of the actual management of the organization.

Selling.—As against an attempt for each society to market its cotton individually, the arrangement for all co-operative cotton to pass for sale through one national sales agency holds obvious advantages, which moreover have been definitely proved by past performances.

In the cotton market quantity is of considerable importance, and the combination of all societies places the central sales agency in a strong position. The cotton can be pooled into even-running lots; care can be given to all details of marketing; direct representation on oversea markets can be established through agents or correspondents, and closest touch kept both with the local and oversea markets. The quantity handled is sufficiently large to allow of hedging when this appears advantageous, or of selling "on call," or for forward delivery, or on c.i.f. basis. Very few, if any, of these advantages could be realized by the individual society owing to its relatively small turnover, which alone would debar it from employing a specialist as the central agency does.

As far as selling methods in Durban are concerned, the cotton is sold in much the same way as is spot cotton in Liverpool. The cotton is offered on Government Grading Certificate* and actual sample to local buyers representing Liverpool and continental houses. Terms are net cash against delivery free on rail quayside. Sale by auction, which at one time was prevalent, has now fallen entirely into disuse.

THE WORK OF CO-OPERATIVE SOCIETIES.—It is a truism that all questions which affect the permanently successful development of an industry can only be worked out by the producers themselves, because no one but the producer has a primary vital interest in production. The position here is a particularly happy one in that the movement is built up on the foundation of independent *local* units in which members take an active interest, as the control of affairs rests in their hands and community pride comes into play to see the organization a success. This is particularly noticeable where a ginnery is owned. Where other products besides cotton are handled and no ginnery is owned this interest is not so pronounced, especially during so difficult a period as we are passing through, when bad seasons and low prices combine to let interest in cotton growing flag.

* See also "Cotton Grading in South Africa," by T. G. Hesse, EMPIRE COTTON GROWING REVIEW, ii., 2, 1925, p. 117.

The industry owes much of its advance to the services of the Cotton Specialists of the Department of Agriculture and of the Empire Cotton Growing Corporation, but it is doubtful whether these officers could have achieved as much without the support of the co-operatives and the unity of action brought about by co-operation in such matters as pure seed control and distribution, insect-pest control, agricultural practices, etc. Practically each cotton area has its co-operative organization, which serves as a forum in which members may discuss questions affecting the industry in general, and local affairs in particular.

The central body represents the combined societies in their public relationship, and indeed the Central Co-operative Cotton Exchange, Ltd., is acknowledged officially as the representative of the cotton-growing industry. Any policy evolved by an individual society is discussed at the periodical meetings of the central body, which then may proceed with the matter by taking it to the proper quarters.

In this way the Central Co-operative Cotton Exchange has been very closely associated with such matters, amongst others, as the introduction of the Government grading and baling regulations and the establishment of levy funds.

The levy is of 1s. per hundred pounds of lint exported, the monies raised being under the direct administration of the Minister of Agriculture, and available only for assisting the further development of the cotton-growing industry. All disbursements are made in consultation with the Central Co-operative Cotton Exchange, Ltd. In view of the fact that the establishment and successful working of this organization was handicapped by lack of funds, the Minister directed that the expenditure of the organization be covered out of levy funds. Apart from these disbursements the levy funds have been used for such varied purposes as expenditure in connection with special investigations and experiments, salaries of official seed-cotton classifiers and of an entomologist, bursaries for cotton-grading apprentices, etc.

Organized primarily to render services to its members, the co-operative movement endeavours to be of benefit to the cotton-growing industry as a whole.

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Received August, 1927.

THE THINNING OPERATION IN COTTON GROWING

A Preliminary Note on the Time of Thinning in its Relation to the Early Development of the Seedling during Periods of Water Stress.

BY

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The present paper contributes some results secured in a Time of Thinning Experiment carried out by the author at the Empire Cotton Growing Corporation Experiment Station, Magut, Natal.

The past two seasons have experienced a low rainfall of uneven distribution, producing periods of plant distress, and amongst stands of seedling cotton growth has been barely perceptible for periods of weeks. The plants frequently take on a sickly, yellowish hue, the leaves droop continuously, and the stems redden and harden. A growing rain, breaking the drought conditions, may not influence the onset of new growth until much valuable time and soil moisture have been lost in correcting the normal interplay of osmotic and turgor pressures, and in restoring active metabolism. As a rule, many plants succumb prior to the advent of the relieving rain; the stand may be seriously reduced, and it is questionable if the distressed plants ever crop fully, despite good rains thenceforth, after checks of such severity; it is also probable that the plants are rendered more susceptible to disease.

Growers in this area have regarded plants of 9 to 12 inches in height as being ready for thinning. It was decided to study the response of the plants to a thinning operation at various average plant heights, primarily to observe if early reduction in root competition and plant tissue temperature would stimulate the growth of the remainder, and to observe and measure plant behaviour in the direction of fruit scaffolding and vegetative growth.

It would appear that widely distributed periods of droughty conditions may be expected in the early season, year to year. Apart from these general conditions there is great variation in the volume of rainfall on adjacent farms at times of precipitation. Probably from topographical reasons many farmers commonly experience short rains.

Experimental Methods.

The plots studied were laid down in chessboard fashion. Each plot was $\frac{1}{40}$ acre in extent, and provision was made for two guard rows on the margin of each plot. Burd* has shown that two marginal rows are probably insufficient to check outside row effect, but the total area was sown solidly to the boundaries, and only plants in the middle rows of each plot were studied. The interplot rows were not cut out until the termination of the observations, consequently the plants dealt with may be considered free from undue lateral influence. The plots were in quadruplicate. The average plant heights at time of thinning were 4, 6, 8, 10, and 12 inches.

The plots were sown on November 4, following 0·75 inch of rain. The rainfall bar chart in Fig. I. is given without regard for a regular time interval up to November 15. This has been done in order to include all the early season precipitation.

The subsequent seedling growth was very slow, and the plants had only attained an average height of 4 inches on December 3. On this date the plots to be studied at the 4-inch height were thinned to one plant per 18 inches drill interval. During the period November 3 to December 3, the low rainfall had brought about acute distress in cotton crops in the neighbourhood of the Experiment Station.

In each thinned plot 5 plants were taken, at random, for individual study. In each of the series studied, therefore, the results from 20 plants were noted, making a total of 100 plants for the whole series. In addition to these, 20 plants were marked in the interplot rows, to serve as check plants. The returns for all unthinned rows were taken from these plants until the average height of the whole was 6, 8, 10, or 12 inches, as the passage of time went on. It will be seen from the main stem growth curves in Fig. I. that individual lines draw away from the thick bulked line. These departures mark periods at which measurements were taken in the respective series following the thinning operation.

Measurements of the mean elongation of the main axis were made at weekly intervals, the first measurements being taken one week following the reduction of the stand. The measurements were taken from the cotyledonary nodes to the growing point of the main stem, using a straight-edge ruler or length of cord as the distance required. The growth increments are expressed as week-to-week increases.

* Burd, L. H., Reports on Research Work, Cotton Experiment Station, St. Vincent, Empire Cotton Growing Review, vol. ii., p. 235.

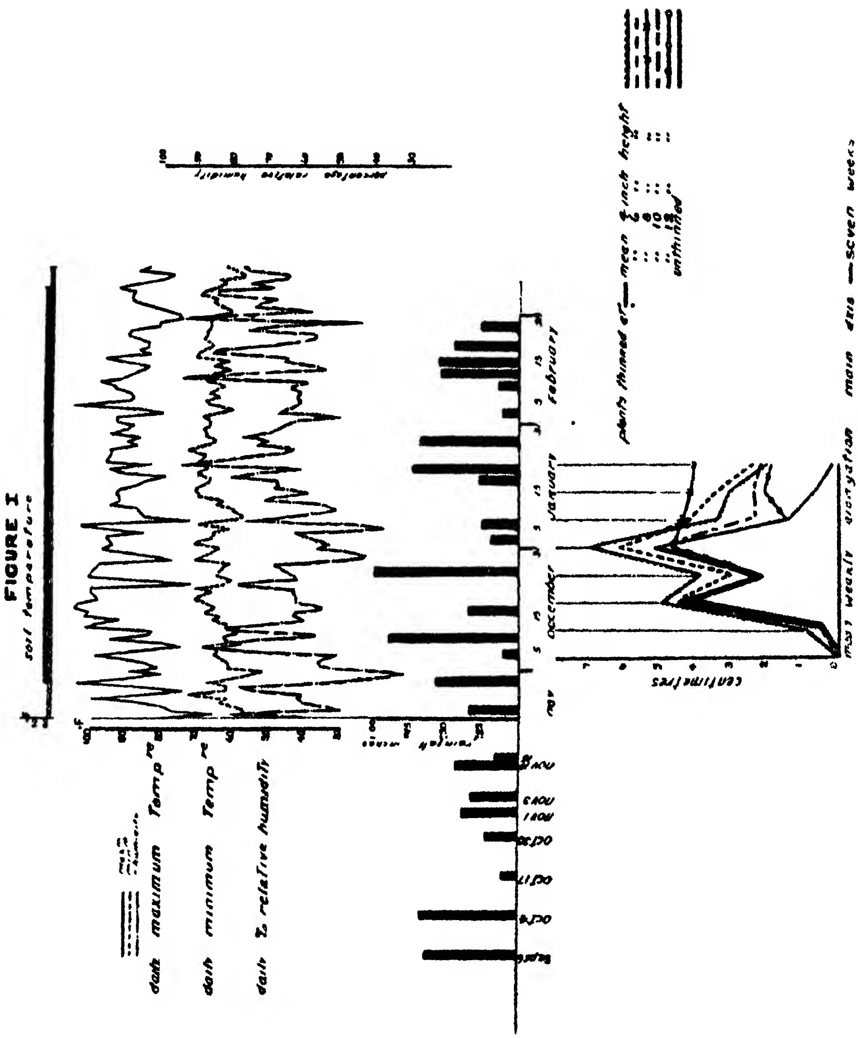


FIGURE I
soil temperature
daily maximum Temp °F
daily minimum Temp °F
daily % relative humidity
percentage relative humidity
December
January
February
centimetres
plants thinned at — mean inch height
unthinned
mean weekly elongation main axis — seven weeks

The standard deviation of the mean of 20 growth measurements showed that a random sample of 20 plants would provide a representative population for purposes of this investigation.

On the appearance of the first flower buds, plant diagrams were constructed. Five plants were taken at random in each series from amongst plants already marked, and diagrams such as are depicted in Fig. II. were made from these plants in the course of growth. Each dated square represents a flower bud observed on that date at that fruiting node. Monopodials are lettered M. The diagrams are self-explanatory in construction.

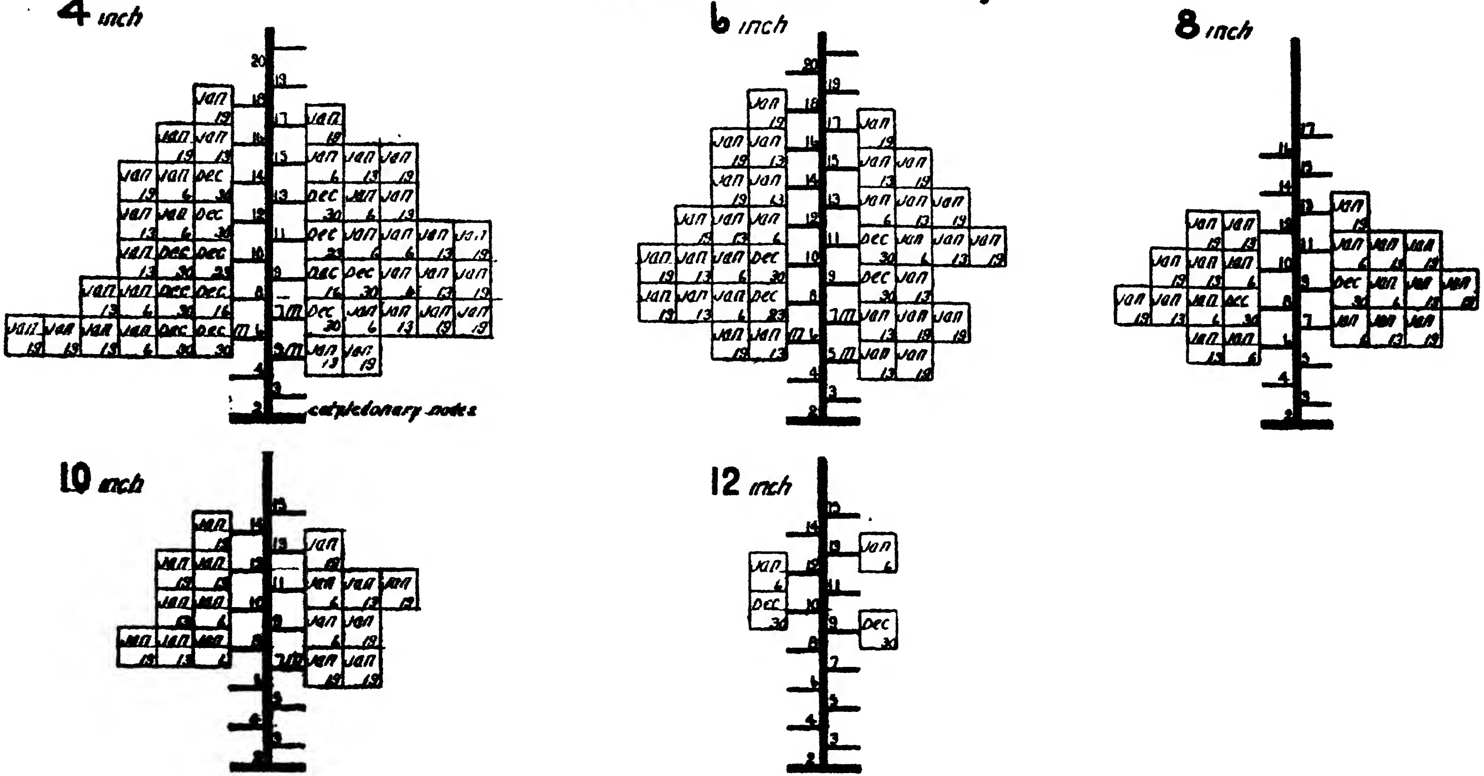
On the appearance of the first few flowers in the earliest plots, daily flowering records were taken. The flowering curves, smoothed by overlapping five-day means, are given in Fig. III. The dearth of flowering is referred to later.

The flower-bud diagrams and flowering records were taken in order to study any earliness and increased volume of fruiting initiated amongst the earliest thinned plots. It was hoped to escape the ravage of bollworm (*Diparopsis castanea*) on the marked plants by frequent examination for and destruction of the eggs. This measure greatly reduced bud loss. The diagrams were confined to bud records owing to bollworm.

Data from the Experiment.

It will be evident from a consideration of the curves for mean weekly elongation of the main stem that the earliest thinned stands, 4 and 6 inches, have shown an appreciably greater growth than the unthinned rows, and that in all cases the week following the release from competition has produced a rise in the growth curve. This is most marked in the 4 and 6 inch thinnings, following the rain in the third week of December. These curves then descend, and examination of the flower-bud diagrams for the following weeks shows the production of numbers of buds, indicating that the main axis growth is slowing, and that food materials are being diverted to the fruit scaffolding and lateral vegetative growth. Assuming the translocation of growth matter to the fruit scaffolding, the fruit and purely vegetative tissues, the prolongation of the 8-inch axis is to be expected, the onset of budding being decidedly later in this series. In the latest thinned groups, the rise of the curve on thinning is not great, and later measurements, uncharted, show this to have ceased entirely, until after the rains at the end of January. Growth in these series was then resumed, and flower buds were laid

PLANT DIAGRAMS — height of thinning



down. The difference between the 10 and 12 inch thinnings is, however, marked.

At the conclusion of the growth measurements, the plots showed wide variation in size and vigour, ranging in sequence 4 to 12 inch thinnings.

The plant diagrams depicted are to be taken as representative of the conditions existing on the same day amongst the various groups. Only one diagram is given for each group. These do not depart materially from the others of their respective series. The diagrams show the number of buds set on the marked plants in each series or thinning group, when the budding records were discontinued and daily flowering records undertaken. The number of buds set per plant (diagrams) is as follows:

4 inch plots	46 buds
6 inch plots	35 buds
8 inch plots	22 buds
10 inch plots	16 buds
12 inch plots	4 buds

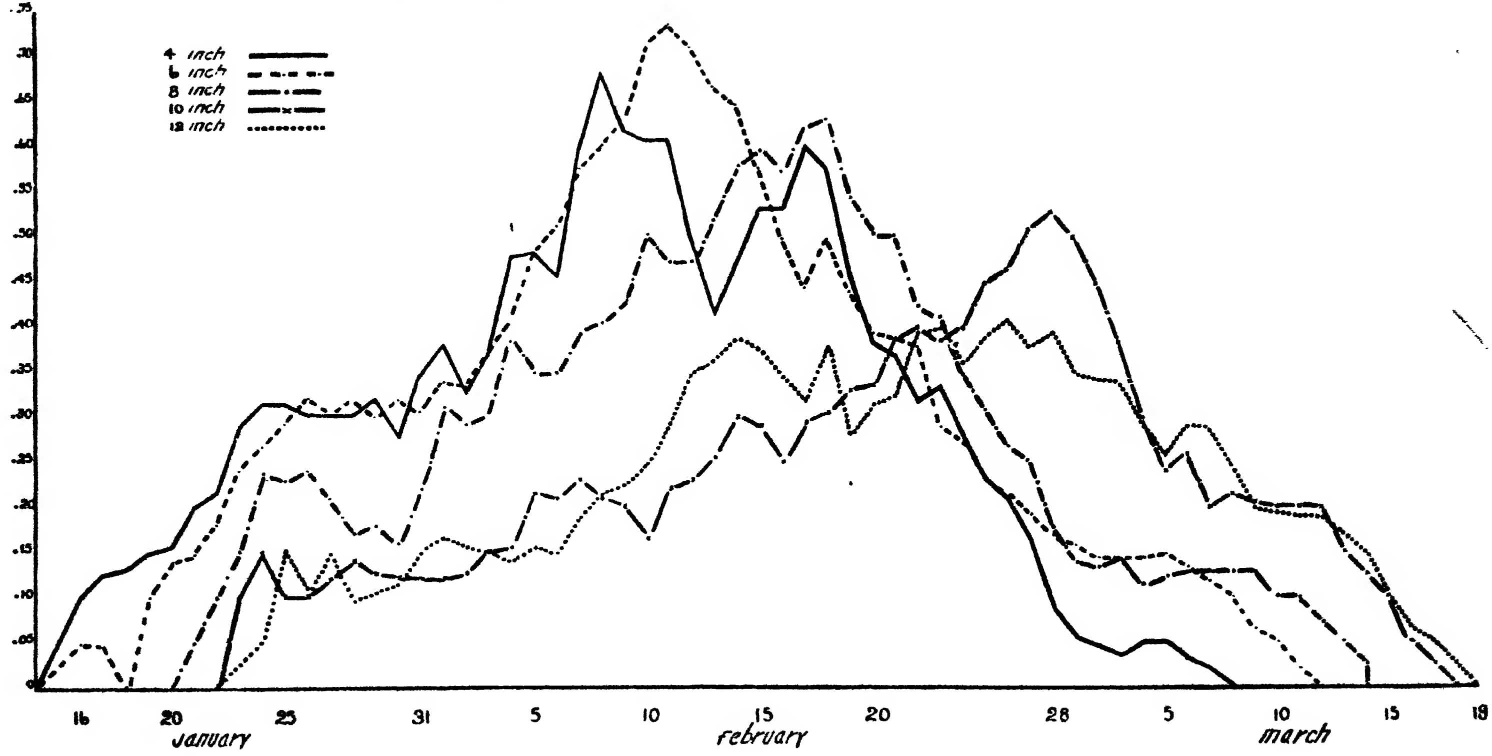
It must be pointed out that the records were made at weekly intervals, and that the date given in each square is the date the bud was actually observed. Such weekly observations preclude the possibility of accurately dating buds. Mason* has pointed out that a careful inspection will generally reveal the presence of the flower bud from three to five days preceding the unfolding of the attendant foliage leaf in Sea Island cotton. No attempt was made to observe buds in this investigation until after the unfolding of the attendant leaf. It will be observed that the dating of the buds, as given, has permitted overlapping which is not normal to the spiral course of fruiting in cotton.

No blank node intervals have been left where minute flower buds shed before observation, nor have bud shedding records been taken. The problem has been studied, in this instance, mainly from the points of view of plant relief and growth stimulation during a critical period in the early growth stage, or as a measure to hasten the growth of late-planted cotton. It is probable that, during the period of record, early shedding has stimulated increased budding among the earlier thinned plots in response to variation in the soil moisture content, and in the water balance of the plant. From visual observations, the extra count of buds arising in this manner is not believed to have materially affected the relative position of the

* Mason, T. G., "Growth and Abscission in Sea Island Cotton," *West Indian Bull.*, xix., 214-38.

FIGURE III

flowering curves flowers per plant per day
smoothed by overlapping five day means



budding, as shown in the diagrams. In any event, it may be pointed out again that the object of the experiment was to see if plant distress could be relieved, in the early season, with the expectation that later rains would provide reasonable growing conditions.

The curves, flowers per plant per day, Fig. III., show a paucity of flowering that we ascribe to bollworm ravage; shedding must also be accorded prominence. The 4-inch thinning suffered most heavily from bollworm. Present records point to a heavy spring infestation of bollworm, rising to a maximum in December, and tailing off gradually in January to rise to a second peak in March. The 4-inch thinning encountered the full weight of the December ravage. As the flowering records were taken on many plants which could not be closely examined for moths and eggs, the 4-inch plots and, to a somewhat lesser degree, the 6-inch plots were most heavily infested. Despite this, the flowering peaks are in sequence, with one exception, and show a wide time interval between the 6 to 8 inch and later thinned groups. The 10 and 12 inch flowerings have been comparatively slight. The 12-inch curve falls below that of 10 inch. These plants were unable to recover from the severe conditions of root competition during the period from germination to the reduction of the stand.

Considering the subsoil aridity occasioned by the drought conditions of the season 1925-26, and the short and infrequent rains of 1926-27, one would expect surface rooting to be general. This occurred, and no doubt the early thinned plants were stimulated in the direction of surface rooting to a greater extent. Plants, pulled out, exhibited very short, crooked tap-roots or a mere semblance of a tap-root. One or two good soaking rains would have produced more normal root behaviour, however, as would subsoil moisture reserves.

Further experiments are needed to confirm and amplify the above results.

During the course of the experiment, it was observed that the delayed thinning, and thus delayed fruiting, of the plants did not expose them to bollworm feeding from the heavy spring infestation. This aspect of the operations will form matter for future study.

Received August, 1927.

COTTON PICKING BY MACHINERY

BY

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It is an extraordinary fact that from time immemorial, when cotton in its wild state was first utilized by man for his domestic needs, there has been no material change until quite recently in the method of harvesting the crop in any of the cotton-growing countries of the world. There is probably no crop cultivated on a commercial scale where so little progress has been made in improving the method of harvesting or in economizing labour and reducing the costs of the harvesting operation.

Cotton picking is by far the heaviest single item of expenditure which contributes towards the costs of producing the crop. Of the 30,000,000 odd bales of cotton grown annually, representing roughly 22,000,000 tons of seed-cotton, it has all along been the practice to gather every ounce of this crop by hand. By taking the average cost of picking at 1d. per pound of seed-cotton it is estimated that the annual cost of picking the world's cotton crop by hand is approximately £200,000,000. It certainly does seem paradoxical that in this so-called " mechanical " age so little progress should have been made in devising more economical means of harvesting the crop.

The cotton crop is ready for harvesting only when a fair proportion of the individual capsules, or bolls, have dehisced as the result of desiccation following the maturity of the seed contained in them. On dehiscing, the lint-covered seed is exposed, the moisture contained in the lint evaporates, and the elastic and spiral properties of the individual fibres on the seed cause them, on drying, to disentangle themselves from the closely knitted mass as seen in the immature and unopened boll. When completely dried in the field the contents of the boll may, in certain varieties of cotton, expand to such an extent as to assume proportions many times the size of the original capsule. It is at this stage that the cotton field assumes its characteristic appearance.

There are incipient difficulties associated with the mechanical picking of cotton which, in the past, have proved insurmountable. The cotton plant, unlike cereals and various other crops, does not

mature uniformly. The earliest bolls on any single plant may open in July and the latest in December, and it may continue to produce matured bolls regularly during this protracted period. Normally the cotton farmer delays picking until there is a sufficiently large flush of opened bolls to justify the operation. There are usually three such flushes corresponding to the " bottom," the " middle," and the " top " crop. Most of the world's cotton crop is grown by tenant farmers on small farms. These farmers are for the greater part illiterate natives of the Tropics or sub-Tropics, whose needs are few, whose standard of living is exceptionally low, and who make unreliable handlers of machinery in the absence of adequate supervision. The trade requires clean cotton free from all foreign matter such as burrs, broken leaf, sand, etc., and with a minimum of immature fibres. The picking machine, to be successful, must not damage the gathered fibre nor the live vegetation on the plant when picking the first and second flushes. If the present practice of small cotton farms is to continue, then the " picker " must be marketed at a price within the means of the small farmer. It must be light weight and simple in construction, and it must be able to pick at a rate not less than about 1,000 lbs. of seed-cotton per working day of, say, ten hours, and at a cost well below two dollars per 100 lbs., which is the average cost of hand picking in the States. The machine-picked crop must be delivered to the consumer at least as clean and in as good condition as the crop picked by hand. These are some of the worst difficulties which confront the inventor of the successful mechanical picker.

Such a machine would have the great advantage of picking the whole of the crop before the opened bolls would have time to be deleteriously affected by adverse climatic conditions such as frost, rains, and dew, and by insect pests and diseases. The world's cotton crop is now depreciated in value to the extent of millions of pounds sterling yearly, solely by the inability of the farmer to complete the harvest before adverse seasonal conditions of climate and labour set in. With a successful mechanical picker, the farmer's cultivable area under cotton need no longer be limited to the crop which he and his family can pick by hand during the season.

The writer, during a recent tour of enquiry through the Cotton Belt of the United States of America, investigated the agricultural economic conditions in general, and, in particular, the progress that has latterly been made in the methods of cultivating and handling the cotton crop. He considers recent developments in this connection in the United States to be of such importance as to deserve the attention and the close study of all who

may be interested in the development of the cotton-growing resources of the British Commonwealth of Nations.

It is commonly known that the cotton industry passes through fairly frequently recurring phases of prosperity and depression, dependent on the relation obtaining at the time between the world supply of, and the world demand for, the raw product. Farm labour prices in the cotton fields do not and cannot fluctuate commensurately with the price of raw cotton. The standard of living is based on either a fixed or an assumed wage, in either case with a narrow margin and an upward tendency from year to year. When cotton passes through a phase of high prices, extending possibly over a period of years, there is a tendency for wages of cotton pickers to increase. On a sudden fall in the price of cotton, the farmer finds himself unable to return to his earlier and lower standard of living. In the Cotton Belt of the States agricultural wages have in recent years been largely influenced by the high degree of industrial prosperity which the country enjoys, and also by the substantial increase in the total crop produced. These factors tend to accentuate the difficulties of the cotton farmer in harvesting his crop, and to force him to seek for means to dispense to a greater degree with manual labour.

During the phases of depression history in the cotton fields repeats itself, in that the costs of production exceed the value of the crop, and harvesting becomes an uneconomical proposition. This applies more particularly to the late and low-grade portion of the crop which remains to be picked at the tail end of the season. Such phases of depression were experienced in 1914-15, and again in 1926.

Snapped Cotton.—It was during the 1914-15 phase that the practice of *snapping* first became prominent. The cotton is obtained by gathering the seed-cotton intact with the dry capsules or burrs in which it is contained. It would appear that the only advantage in snapping cotton is that in the absence of an adequate labour supply at a reasonable wage a large portion of the cotton crop would otherwise either have to be abandoned or left in the field until well into the winter months, to be picked at the convenience of the farmer and his family. Under normal conditions, with a fair wage level and a moderate price for raw cotton, the practice of snapping cotton is not an economical proposition. But where wages are high, labour scarce, and cotton prices low, then snapping has decided advantages over picking.

It may well be asked why the practice of snapping did not become established before 1914-15 in the Cotton Belt of the States, or elsewhere for that matter. The answer is to be found in the equipment

of the modern cotton gin. Snapped cotton was not a marketable commodity until gin manufacturers had improved their machinery to such an extent as to enable the dry capsules to be extracted from the harvested produce before the seed-cotton was subjected to the usual process of ginning. This is a development of the last decade or so, and the additional boll-breaking and boll-extracting equipment has reached its present high stage of efficiency only within the last three years.

Practically all the ginning installations erected during the last two years, either as replacements all over the Cotton Belt or as new installations in the Middle West, are equipped with boll-breaking and extracting machinery. In addition, the older installations are now, at an increasing rate, being fitted with this extra equipment.

The quantity of snapped cotton marketed from the 1926 crop has been variously estimated at 2,000,000 to 4,000,000 bales. The trade will probably never know the exact quantity of snapped cotton harvested in any year. Owing to the prejudice with which snapped cotton is regarded by the trade, and to the fact that it is not tenderable against futures contracts, coupled with the discount made by buyers for snapped cotton, the private owners of gins try to conceal the fact that any portion of their crop has been snapped.

To one accustomed to the handling of hand-picked seed-cotton, snapped cotton as gathered in the field would appear to be fit only for the manure heap. But thanks to improvements in ginning machinery, the burrs and dry broken leaf can now be removed so effectively that few experts can distinguish between snapped and picked cotton after ginning. except, of course, when the samples concerned have been gathered from the same field on the same day, in which case the snapped cotton will be found to have slightly more broken leaf or pepper. On closer scrutiny, however, the snapped cotton will reveal the presence of another form of foreign matter in appreciable but varying quantities, which may well prove to be of prime importance to the spinning trade.

In the process of snapping cotton a part of the pedicel which supports the boll on the branch is inadvertently gathered with the cotton and the bolls in which the cotton is contained. Improved ginning machinery can effectively remove the bolls and broken leaf sufficiently to make the commodity marketable. But the same machinery is unable to remove the pedicels referred to, so that in the process of ginning these pedicels are battered until the wood is converted into pulp and the fibrous bark in which the pulp is contained retains its tensility to form what is known in the trade as " *cricket*

legs." The presence of "cricket legs" detracts from the value of the raw cotton, because they cannot be completely removed either in the ginning or the spinning. This results in a high percentage of *broken ends* in the spinning frames. The writer heard of numerous complaints directed against snapped cotton for this specific reason by spinners in the States. The high percentage of immature fibres also gives trouble during bleaching and dyeing. But it is probable that if snapped cotton continues to increase, suitable machinery will in the course of time be invented to deal adequately with all foreign matter contained in it. In the meantime it is not at all improbable that much snapped cotton will be tendered against futures contracts for American staples and grades. The presence of "cricket legs" is the only distinctive feature by which it can be distinguished from picked cotton.

Most of the snapped cotton marketed up to the present year has been consumed in the States and on the Continent, and it is believed that only a small proportion of it has been shipped to Liverpool. But increasing quantities of it can be expected, and more especially the low grades and shorter staples in years of low prices. This brings us to the consideration of *sledded* cotton.

Sledded Cotton.—Once a machine was devised to handle snapped cotton at the ginnery in such a manner as to render it marketable, the farmers were not slow in devising means of hastening the process. This they have succeeded in doing with the *sled*, a primitive-looking machine composed of a wooden box or crate open on top and at the front end, and mounted on two sleds or runners. The dimensions of the sled vary; the average size is about 4 feet wide, 3½ feet high, and 6 to 8 feet long. It has a capacity of about 500 lbs. of sledded cotton, and is drawn by two large mules or horses. When the sled has been filled its contents are dumped on the headlands.

The earlier types of sled were fitted with a V-shaped notch in the centre of the fore end at ground level. This notch leads into a metal-lined groove ⅜ inch wide reaching to the rear end of the sled at an angle of 30 to 45 degrees. The more recent types are mounted on two wheels at the rear end, and are fitted with a fork of 8 to 16 prongs which replaces the V-notch of the earlier types; the tips of the prongs are tilted upwards so as to ride freely on the soil surface, and some sleds are fitted with a lever to adjust the fork to inequalities in the soil surface. A boy stands inside the sled to rake in all cotton gathered by the fork.

With the earlier types of sled there was much wastage through cotton being shed at the time of sledding; and even with the improved

COTTON SLED, EARLIEST TYPE WITH "V" NOTCH ONE SLOT

COTTON SLED; SINGLE ROW IMPROVED "FINGER" TYPE

finger type anything from 5 to 25 per cent., dependent on the operator and on the nature of the fittings, may be lost from this cause.

Sleds are made by local village artisans, and supplied at a cost varying from 8 to 35 dollars. Some of the more prominent implement makers in the States are now devoting their attention to the wholesale manufacture of improved sleds, and some farmers are beginning to use 2 and 3 row sleds. The harvesting capacity depends mainly on the acre yield of the crop, and with a crop yielding one-third of a bale per acre the one-row sled can harvest 2 to 2½ bales of cotton per day of 10 hours. There are no accurate data of areas and quantities sledded in 1926, but the quantity is variously estimated at 200,000 to 400,000 bales.

Sleds first came into prominence in 1924, and their use increased at an exceptional rate during 1925, and more especially during 1926, with the heavy fall in cotton prices coupled with a labour shortage and a record crop in the Middle West.

The practice of sledding is at present almost entirely confined to the high-lying plains of North-West Texas and Oklahoma, for the reason that climatic, topographic, and economic conditions in general are there best suited to the use of the sled. Incidentally, there are no serious insect pests or diseases, other than root-rot, in this tract, which lies outside the boll-weevil zone.

Sledding is not undertaken until the first frosts have killed all vegetative growth on the plant and the matured bolls are fully opened. The plants seldom exceed 18 inches in height, and they generally vary from 9 to 15 inches. The Department of Agriculture has been engaged for some time in breeding plants well suited for sledding, and the writer saw at one of the Texas Experimental Stations plants with the fully matured cotton appearing like an inverted bunch of grapes around the main stalk.

Conditions under which sledding may be considered to be a practical and profitable proposition may be briefly described as follows: unirrigated cotton, low rainfall, a growing period of 125 to 135 days followed by frost, small stunted plants with few if any vegetative branches, evenly-maturing cotton and wind-resisting opened bolls, flat or slightly undulating country with large fields, high labour costs, proximity to a ginnery equipped with boll breakers and extractors, and a crop yielding an average of not less than 125 lbs. lint per acre. In years of high prices wage-labour should be engaged in so far as practicable for hand picking the earlier flushes.

There are estimated to be about 10,000,000 acres of unbroken cattle-ranch land in West and North-West Texas and in Oklahoma

which fulfil the above conditions. Land is relatively cheap (£4 to £8 per acre, part payable in cash, and the balance in ten yearly instalments, for unbroken and undeveloped land which needs no clearing), diversification with grain sorghums and cattle feeding is an economic proposition already being practised, and one man with his family can conveniently cultivate and harvest 100 acres of cotton as compared with 12 to 15 acres in other sections of the Cotton Belt.

Sledded cotton possesses all the defects of snapped cotton; and, in addition, it contains a higher percentage of immature fibres resulting from the gathering of *bollies* by the sled, which does not discriminate between mature and immature bolls. Bollies are immature bolls killed or injured by frost or other agency.

There is a divergence of opinion amongst experts as to whether the practice of sledding will continue in vogue under more normal conditions of cotton prices and labour wages. From a personal study of general economic conditions in the Cotton Belt during the latter part of the harvest season of 1926, the writer is of the opinion that not only will the practice of sledding continue, but the cotton sled will be improved so as to result in less wastage in the field, and its use will be extended, irrespective of cotton prices, to all parts of the Cotton Belt where the general economic conditions detailed above obtain.

The subjoined tabular statement serves to illustrate the substantial economy which can be effected by using the sled, and also some of the relative advantages of *picking, snapping,* and *sledding* cotton.

Method of Harvesting.	*Distribution of Harvesting Methods in N.W. Texas.*		*Cost per Bale of 500 lbs.*			*Amount required to make Bale of 500 Lbs.*	*Man Labour required to Harvest Bale of 500 Lbs.*	*Average Amount Harvested per Man per Day of Ten Hours.*	*Ginning Percentage.*	*Equivalent Lint Cotton Harvested per Man per Day.*
	1925	1926	*Harvesting.*	*Ginning.*	*Harvesting and Ginning.*					
	%	%	$	$	$	Lbs.	Hours	Lbs.	%	Lbs
Picked .	50	32	16·18	6·15	22·33	1,380	49	284	36·2	103
Snapped	45	35	14·04	9·80	23·84	1,950	34	579	25·6	148
Sledded	5	33	2·73	9·84	12·57	1,960	5	3,922	25·5	1,000

The above data are based on averages from returns made by about fifty farmers in North-West Texas, whose individual areas under cotton averaged 97 acres in 1925, and 116 acres in 1926. A discount of 1 cent to 2 cents per lb. from the ruling price for the same

COTTON SLED: IMPROVED "FINGER" TYPE ON WHEELS

The plate illustrates typical N.W. Texas cotton field in December

grade and staple of picked cotton was being made at Lubbock, Texas, in December, 1926, for snapped and sledded cotton. It is of interest to note that the total expense of harvesting and ginning snapped cotton is greater than that of picked cotton. But snapped cotton helps to make the farmer independent of transient casual labour, and sledded cotton makes him wholly so. The progressive Texas farmer who takes advantage of these time-saving and labour-saving devices can operate, without extra help or additional finances, a sizable increase over his former acreage at a decidedly lower cost per acre on his customary quarter-section of 160 acres.

Quality of Snapped Cotton.—With the primary purpose of determining how and to what extent the grade and the spinning properties of cotton are affected by the snapping method of harvesting, the U.S.A. Department of Agriculture conducted tests on representative samples of the 1925 crop in Texas and Oklahoma. Every precaution was taken to ensure evenness in handling the picked and snapped samples from the field to the finished yarn. As this work has a distinct bearing on the subject of the present article, the summary of the report is here reproduced *in extenso*:

"Four lots of cotton were used in this test, two grown in Oklahoma and two in Texas, alternate rows of the same field being picked, and the intervening rows being snapped. The snapped cotton in each case was classed two grades lower than the corresponding picked cotton. The lots were manufactured into yarns under similar moisture and mechanical conditions.

"The cleaning machines removed approximately 5 per cent. more waste from each lot of snapped cotton than from the picked lots. This difference in waste is in line with the difference in grade. The lowering of grade in the case of the snapped cotton is the direct result of the snap method of harvesting.

"No special difficulty was encountered in manufacturing these cottons into 22's, 28's, and 36's yarns. All the 22's yarns broke above the new Draper standard, as did all of the 28's except those spun from the Oklahoma snapped cotton, which fell slightly below. None of the 36's yarn reached standard, since this number is out of the range of the length of staple of these lots. In both cases the yarns from the picked cotton broke slightly stronger than those from the snapped cotton. The difference in strength between the Texas picked and snapped cottons was negligible. The difference in the irregularity of yarns spun from the picked and from the snapped cottons was inconsiderable.

"The decreased cost in harvesting the cotton by the snap method is much more than offset by the extra expense of passing cotton through the boll extractor and by the loss of value resulting from the lower grade caused by snapping.

"The test, though not presented as conclusive, indicates that snapping as a method of harvesting lowers the grade of the cotton by about two grades; that, with efficient boll-extracting equipment, the spinning qualities of a cotton are not noticeably affected; that the percentage of visible waste in snap cotton is not materially greater than in picked cotton of equal grade; and that, taking these

* "Spinning Tests of Picked and Snapped Cottons" (Texas and Oklahoma, 1925 crop). By Horace H. Willis, U.S. Department of Agriculture, September, 1926.

results as typical, snapping cotton at the ordinary quoted prices and under the conditions which prevailed in 1925 resulted in a loss to the grower of $7.29 a bale as compared with picking.

"When greater discounts were assessed against the cotton because of its being snapped, and when the cotton was sold in the seed, this loss was from approximately $14 to $27 per bale.

"Since this is the first comparative test of picked and snapped cottons, and since the price data used in this particular test cover a comparatively short period, further tests are being planned in order to ascertain the comparative value over a period of years of the methods of harvesting."

For the purposes of the report now referred to, the average price of Middling cotton was taken as 26·199 cents per lb. On the basis of prices ruling in New Orleans at the end of the 1926 season—namely, 12 to 15 cents per lb.—the estimated *direct* loss incurred by the farmer in snapping his cotton is considerably less than indicated in the report. Moreover, no reference is made to the *indirect* benefits associated with the practice of snapping which have been already dealt with in the present article, nor is reference made in the report to broken ends in the process of spinning. It should be specially noted that the summary given above deals with *snapped* cotton, and it would be unwise to generalize from this that the same conditions would apply to *sledded* cotton, which generally contains a higher percentage of "cricket legs" and of immature fibres derived from bollies gathered in the process of sledding.

Both snapping and sledding are practices in the right direction, in that they enable the farmer to cut down overhead expenses by increasing production per capita of labour. In a comparative survey of costs of producing cotton made by the U.S.A. Department of Agriculture in 1923 on a large number of farms in eight representative territories in the Cotton Belt, *before* the sled was in general use in Texas, it transpired that cotton farmers in Lubbock County, Texas, raised cotton at an average cost of 10 cents per lb., as compared with 57 cents per lb. in Lee County, Arkansas; and that the net cost of harvesting per acre ranged from $18.22 per acre in Lubbock County to $50.97 in Johnson County, North Carolina.

With the sled a further saving of about 2 cents per lb. of lint can be effected, but this has to be discounted in part, on account of wastage in the field estimated on an average to be equivalent to about 1 cent per lb. of raw cotton sledded with the basic price of American Middling in Liverpool at 8d. per lb. This leaves a net cost of cotton production in North-West Texas of 9 cents per lb. when using the sled for harvesting. With 2-row and 3-row sleds, and with a machine which can break and extract the burrs in the field at the time of sledding, further reductions would be made in the costs

of harvesting. This line of development is now receiving the attention of farmers and of agricultural machinery makers in the Cotton Belt.

The Mechanical Cotton Picker.—This is distinguished from the sled in that it picks the cotton clean in the field, whereas the sled is a mechanical cotton snapper.

During the past fifty years the picking of clean cotton in the field by a mechanical device has received the attention of many of the agricultural machinery firms in the States and of local inventors in the Cotton Belt. Various ingenious devices have been experimented with, and more than one company has been promoted, but so far without success, to exploit some of these inventions.

The earlier types of picking-machines operated on the pneumatic suction principle, and had the appearance of a dry-land octopus. The individual tentacles had to be presented to each fully opened boll. These machines picked clean cotton, but they were too slow in operation to effect a material reduction in the costs of harvesting. The historical development of the mechanical cotton picker is of great interest. It will, however, suffice for the purposes of the present article to deal with the latest developments in this direction.

In view of the considerable progress which has been made in utilizing labour-saving machinery in industrial concerns in the United States during the last decade or so, it does appear to be anomalous that, except for recent developments in the Middle West section above referred to, the methods of cotton production practised in the slave days have not changed to an appreciable degree. Admittedly more fertilizers are now being used, improved varieties of cotton are being grown, mule draught has in small part been replaced by tractor draught, the efficiency of ginning machinery has been increased, and there is more co-operative marketing; but agricultural wages, and also the cost and maintenance of implements and of draught animals, have risen out of all proportion to the few advantages resulting from improved methods of culture and of handling the crop.

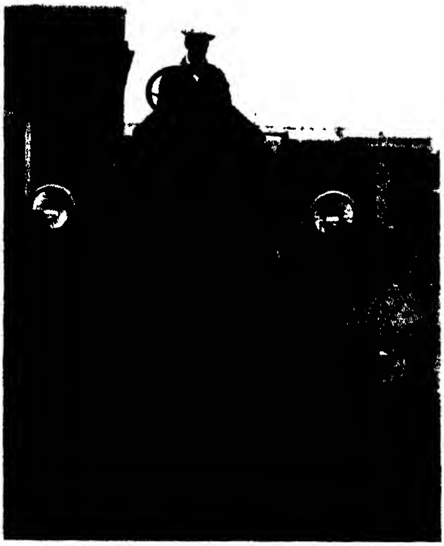
There has been, and still is, a big field for enterprise and for inventive genius in cutting out that high peak of expenditure represented by " picking costs " in the production of cotton. The leading machinery makers in the States are fully alive to this fact, and have in recent years devoted much time and money to the problem. They realize that if they can market a successful mechanical cotton picker, then this machine will open the door to a largely increased demand for tractors and tractor-drawn implements for " making " the cotton crop.

During his travels, the writer was given to understand by reliable authority that at least two of the largest implement makers in the States hope to place on the market in the near future a successful mechanical cotton picker. He was privileged to be present at a demonstration of one of the recently invented machines known as the "Berry" cotton picker. This is a self-contained machine weighing about one-and-a-half tons and operated by a 20 h.p. motor engine mounted on a chassis which has a clearance of about 3½ feet to ride over the cotton. The picking device is composed of a large number of spindles carried by two vertical drums situated midway between front and rear wheels. Without detailed description and pictures it is difficult to explain the method of working by which the cotton is actually picked, but this matters little at present. The process is completed in three stages—picking the cotton, removing it from the picking spindles, and delivering it. The cotton, on being removed from the spindles, falls into a receptacle in which the drums are enclosed; it is there picked up by fan suction and delivered into bags attached to two discharge flutes at the rear of the picker.

A demonstration was given in a fully-matured and unpicked cotton crop with plants about 4 feet high, and yielding about ¾ bale of 500 lbs. to the acre. The machine picked about 85 per cent. of the crop on its first attempt, and practically the whole of the remaining 15 per cent. on its second attempt. It picked at the rate of about 1 acre per hour with rows 3½ feet apart. Allowing liberally for initial cost, depreciation, driver's and attendants' wages, it is estimated that cotton yielding 1 bale per acre can be picked by this machine at a cost of \$2½ per bale of 500 lbs. ¾ bale per acre at \$3½, and ½ bale per acre at \$5 per bale. These figures compare favourably with \$16 per bale hand picked (in Texas), and \$6½ per bale sledded. (This last figure includes the additional charge made for ginning, but excludes differences due to grade and losses in the field.)

The writer is informed by the International Harvester Company that they are busily engaged in perfecting a mechanical cotton picker which they hope to place on the market in a trial lot of about 100 machines in Texas in the coming season. They state that the approximate price of this machine will be \$1,250; it will require one operator, and will pick 85 per cent of the crop at the rate of 1 acre per hour. This is a two-unit machine—that is, a picker drawn by a tractor—and is a modification of the Price-Campbell machine which was attended with partial success in demonstrations in 1910.

The successful mechanical picker has its limitations, though these are not so pronounced as in the case of the sled. In its present



"BERRY" COTTON PICKER
(Front View)

"BERRY" COTTON PICKER
(Side View)

form it has the tendency to fracture the vegetative parts of the plants being picked, and to shed cotton disturbed by the machine in the adjoining unpicked row. The initial cost may be within the means of only a fraction of the world's cotton farmers, and the intricacies of the internal combustion engine and of the picking device may prove too complicated for general use in the cotton fields. No doubt the working parts will need certain modifications under continuous field conditions, but it is acknowledged by all who have seen a demonstration of the more recent mechanical picking devices that considerable advance has been made towards meeting the cotton-farmers' needs.

Conclusions.—It may be well to consider the probable trend of recent developments in cotton production in the States in so far as they pertain to labour-saving machinery on the cotton farm.

From the writer's personal knowledge of economic conditions in the cotton territories of India, Egypt, the Sudan, and other parts of the Near East, coupled with his recent investigations in the Cotton Belt of North America in representative areas from the Atlantic States to California and parts of Mexico, he is disposed to the belief that the world's cotton industry is on the eve of a radical change in the methods of production, a change that may well prove to be one which will usher in a new era in cotton production, second only in importance to that which followed the invention of the mechanical cotton gin. It will follow in the wake of new labour-saving machinery. It may well effect an appreciable redistribution of some of the major cotton-growing territories of the world. It will tend to lower the price of the shorter staples in general as the result of increased and more economical production by machinery, thereby throwing out of commission extensive areas which in years of normal prices are marginal lands, and bringing in areas that are now uncultivated.

The United States of America, the largest cotton-producing country in the world, will be the first to feel the effect and to benefit from this form of labour-saving machinery—indeed, has already begun to feel it. It is reasonable to expect that the practice of sledding which evolved, has since become established, and is now fast extending in suitable parts of the Cotton Belt, will soon be adopted by pioneers in other countries where labour costs are high.

There are, of course, other means by which costs of production can be reduced, such as the cultivation of better staples, improved tillage methods, and the use of artificial fertilizers. The Atlantic States, originally the home of America's cotton crop, have already seen the writing on the wall; and the planters there have for some considerable

time been obliged to resort to heavy and increasing applications of artificial fertilizers in order to increase the productivity of their land. Texas and Oklahoma will benefit most from the anticipated change in cultural methods. In the Atlantic States there are few farms where cotton can be grown under 16 cents per lb. The Mississippi Valley and similar deltaic lands, thanks to their natural fertility, with their resultant high productivity and relatively low production costs, and also their suitability for the higher-priced stapled cotton, will probably be able to compete on favourable terms with lands in any part of the world where conditions of soil, topography, and climate are similar to those existing in North-West Texas and Oklahoma.

In short, the writer is of the opinion that the time is not far distant when a large and a steadily increasing percentage of the world's cotton crop will, to use an Americanism, be " machine made." And in the interests of Empire-grown cotton, of the millions of acres which remain to be developed, and of the millions of inhabitants in our tropical possessions who are now dependent on the cotton crop as their chief source of income, this question of " machine made " cotton would appear to deserve the attention of our colonial administrators and agriculturists.

This question of the application of machinery to perform the tiresome and costly labour of collection, from time immemorial done by hand, is one of considerable interest. In connection with this article, there should be read four articles upon sledded cotton, in the *Internat. Cott. Bull.*, v. 3, April, 1927, p. 370; *ibid.*, July, 1927, p. 571; and in the *Textile Recorder*, xlv., May 14, 1927, p. 41; and *ibid.*, June 15, p. 39; *cf.* also Abstracts 207 (p. 162), 386 (p. 261), and Abstracts 529, 530, 531 (p. 376) in this volume. The future may lie with *picking* cotton lint from the bolls by machinery, but it is difficult to foresee much future for snapped or sledded cottons, on account of their poorer quality, and especially on account of the presence of "cricket legs," which makes the cotton unsuited to the spinning of good yarns. These cottons are at present extremely unpopular with spinners, and the increasing proportion of undesirable features in many American cottons is frequently put down to the mixing of these cottons in the bale with proper hand-picked cotton.—Ed.

Received July, 1927.

Note received September 12th.

The author of this article writes to say that he has lately been informed that 150 International Harvester cotton-picking machines have been allotted to different agencies throughout the American cotton belt in the current season. These machines have been bought by cotton planters under a guarantee of entire satisfaction or recovery of purchase price. The high reputation of the International Harvester Company as agricultural implement makers is such as to command the confidence of the planters in its statements. The guarantee given supports the fairly general opinion in the States that a rapidly increasing percentage of the cotton crop will be harvested by mechanical pickers.

COMPARATIVE COTTON PRICES—IV

BY

JOHN A. TODD, M.A., B.L.

We continue in this issue the usual annual record of Cotton Prices.

As will be seen from Table I., cotton prices have fallen about 25 per cent. against a decline of only about 5 per cent. in the general Index Numbers. For this heavy drop, the record American crop for 1926 of 17,977,374 bales is responsible, and it is interesting to see how this is reflected in the monthly prices in Table II. The highest quotation for American Middling Spot in Liverpool was 10·36 pence on September 8, but the steady decline almost to the end of the year took the price down to 6·30 pence on December 4. The new year, however, saw a complete change in the trend of prices. Towards the end of 1926, there was inaugurated in America a movement for holding a large proportion of the crop, in order to keep up prices, and the effects of this were seen when the decline was checked during December. The scheme was rendered unnecessary, however, by the rapidity with which the crop moved out of sight, and prices steadily recovered in the opening months of 1927.

A severe reduction of the acreage in America was naturally expected for the season 1927-28, and it was realized that the Mississippi floods and the Texas drought would also curtail production. The rise, therefore, continued, and was accentuated when, after the Bureau had issued in July an acreage figure below market expectations, boll-weevil infestation became general throughout the cotton belt. Although more favourable crop reports caused some decline at the close of the season, the first Bureau crop report, showing an apparent fall of 4½ million bales from 1926, led to a very sharp rise of prices during August.

As will be seen from the table, the premiums of Egyptian over American prices have maintained a high level this season, and the average for the season is somewhat higher than in 1925-26. Premiums fell somewhat when it was realized that the 1926 Egyptian crop would exceed even that of 1925, but with the restriction of the cotton area in Egypt for the new season, they again rose to over 100 per cent. in the case of Sakel.

Table III. shows that, on the whole, the trend of prices for other

varieties was very similar to that of American. It will be seen that Indian prices are higher in relation to American as a result of the short Indian crop of 1926.

As was anticipated a year ago, the lower prices ruling during the past season have reacted on the cotton-growing areas of the Empire, and the table of Empire crops, published in the previous issue of this REVIEW, shows the effect in an almost general decline of production, the outstanding exception being the Sudan.

TABLE I.—HISTORY OF COTTON PRICES, 1899–1927.

SEASON'S AVERAGES.

Season.	*Liverpool Prices (Pence per Lb.).*					*Alexandria.*	*American Price of Upland.*	*Year.*	*Index Numbers of General Prices.*
	Sea Island.	*Brazil.*	*American.*	*Indian.*	*Egyptian.*				
		Pernam Fair.	Middling.	No 1 Fine Oomra.	F. G. F. Brown.	Dols. per Kantar.	Cents per Lb.		
1899–1900	16·7	5·06	4·87	4·40	6·81	12·28	7·60	1900	100·0
1900–01	16·4	5·50	5·16	4·37	6·87	13·80	9·30	1901	96·7
1901–02	19·3	4·87	4·78	4·19	6·31	10·42	8·10	1902	96·4
1902–03	*25·00	5·57	5·44	4·47	8·44	13·65	8·20	1903	96·9
1903–04	28·40	5·16	6·94	5·56	8·56	16·65	12·16	1904	98·2
1904–05	27·12	5·25	4·93	4·62	7·37	13·97	8·66	1905	97·6
1905–06	26·38	6·23	5·94	5·00	9·25	15·99	10·94	1906	100·8
1906–07	36·70	6·97	6·38	4·87	10·37	19·16	10·01	1907	106·0
1907–08	35·59	6·79	6·19	5·03	8·81	18·21	11·46	1908	103·0
1908–09	23·39	5·84	5·50	4·94	8·44	15·46	9·24	1909	104·1
1909–10	32·85	8·34	7·86	6·31	13·12	23·30	14·29	1910	108·8
1910–11	35·62	8·27	7·84	7·03	10·75	20·66	14·69	1911	109·4
1911–12	23·73	6·70	6·09	5·63	9·56	17·25	9·69	1912	114·9
1912–13	25·00	7·11	6·76	6·16	9·79	18·28	12·20	1913	116·5
1913–14	23·47	7·47	7·27	5·88	9·45	19·02	13·49	1914	117·2
1914–15	22·00	5·71	5·22	4·46	7·34	12·01	7·94	1915	143·9
1915–16	27·00	8·22	7·51	6·09	10·42	19·28	11·99	1916	186·5
1916–17	50·00	13·03	12·33	10·32	21·56	37·81	18·41	1917	243·0
1917–18	80·00	24·13	21·68	18·78	†30·97	38·52	28·86	1918	267·4
1918–19	65·00	23·96	19·73	18·13	27·85	37·20	30·36	1919	296·5
1919–20	—	30·00	25·31	19·23	60·34	87·81	38·21	1920	365·7
1920–21	—	13·24	11·89	9·20	30·24	34·50	16·08	1921	229·7
1921–22	—	11·40	11·37	9·60	19·75	34·28	17·78	1922	185·0
1922–23	—	14·62	14·92	11·14	17·29	30·71	24·06	1923	185·3
1923–24	—	18·20	17·66	13·35	21·55	39·79	31·67	1924	193·6
1924–25	—	14·67	13·76	11·95	29·82	39·49	24·27	1925	186·1
1925–26	—	11·09	10·77	8·97	20·05	30·47	18·85	1926	172·7
1926–27	—	8·32	8·15	7·18	15·39	‡21·38	12·44	1927	§164·9

* South Carolina. † F. G. F. Sakel.

‡ Ten months' average. These figures are F. G. F. Brown till 1914, since then composite figures embracing G. F. Sakel, G. F. Ashmuni, and G. F. Brown.

§ Seven months' average.

TABLE II.—SPOT PRICES OF AMERICAN AND EGYPTIAN COTTON IN LIVERPOOL, ALEXANDRIA, AND NEW ORLEANS ON THE LAST FRIDAY OF EACH MONTH.

Month.	*Liverpool.*		*Premium per Cent.*	*New Orleans American Middling.*	*Alexandria F. G. F. Sakel.*	*Premium per Cent.*
	American Middling.	*Egyptian F. G. F. Sakel.*				
	Pence per Lb.	Pence per Lb.		Cents per Lb.	Dollars per Kantar.	
1924–25.						
August ..	15·76	25·15	*60*	24·82	47·75	*92*
September ..	14·09	25·25	*79*	24·80	42·50	*72*
October ..	13·58	25·60	*89*	22·85	46·00	*102*
November ..	13·59	26·20	*93*	23·70	47·87	*102*
December ..	13·24	29·35	*122*	23·75	57·37	*142*
January ..	12·92	31·75	*146*	23·75	61·87	*161*
February ..	13·94	34·90	*150*	25·30	67·63	*168*
March ..	13·88	36·35	*162*	25·10	72·37	*189*
April	13·40	31·60	*136*	24·45	64·12	*163*
May	13·04	30·25	*132*	24·05	60·37	*151*
June	13·53	32·05	*137*	23·90	63·12	*164*
July	13·53	32·45	*140*	24·25	59·89	*152*
1925–26.						
August ..	12·60	28·65	*128*	22·25	52·00	*134*
September ..	12·91	28·00	*117*	22·92	47·75	*108*
October ..	10·35	22·75	*120*	19·07	39·37	*107*
November ..	10·74	19·75	*88*	20·05	35·62	*77*
December ..	10·27	17·65	*72*	20·00	32·87	*64*
January ..	10·63	18·25	*72*	20·07	34·50	*72*
February ..	10·33	17·30	*68*	18·95	33·00	*74*
March ..	10·16	15·60	*53*	18·05	30·50	*69*
April	9·94	16·25	*64*	17·90	31·25	*75*
May	10·33	17·10	*65*	18·00	31·25	*74*
June	9·56	16·35	*71*	17·55	30·00	*71*
July	10·02	16·40	*64*	18·69	29·87	*60*
1926–27.						
August ..	10·17	16·35	*61*	18·49	30·00	*62*
September ..	8·43	17·25	*105*	14·48	33·50	*132*
October ..	6·85	14·65	*114*	12·27	25·75	*110*
November ..	6·92	14·65	*112*	12·61	26·37	*109*
December ..	6·89	14·10	*105*	12·75	25·62	*101*
January ..	7·26	13·65	*88*	13·20	25·25	*92*
February ..	7·77	13·85	*78*	14·06	26·00	*85*
March ..	7·82	13·35	*71*	14·20	26·00	*83*
April	8·35	14·60	*75*	14·95	28·50	*91*
May	8·94	16·75	*88*	16·06	32·37	*102*
June	9·08	16·95	*87*	16·49	32·75	*99*
July	10·05	19·60	*95*	18·33	37·87	*106*
1927–28.						
August ..	11·15	19·45	*75*	21·30	38·62	*82*

TABLE III.—MONTHLY SPOT PRICES OF VARIOUS KINDS OF COTTON IN LIVERPOOL, 1924–27.

ON THE LAST FRIDAY OF EACH MONTH. FROM THE LIVERPOOL COTTON ASSOCIATION'S WEEKLY CIRCULARS.

(For American in Liverpool and New Orleans—and Egyptian in Liverpool and Alexandria—see Table II.)

Seasons.	*Egyptian Uppers (F. G. F.).*	*Peru Smooth (Good Fair).*	*Peru Rough (Good Fair).*	*Peruvian Afifi (Good Fair).*	*Brazilian Pernam (Fair).*	*West African (Middling).*	*East African (Good Fair).*	*Indian No. 1 Good (Oomra).*	*Percentage of Indian on American.*
1924–25.									
August ..	21·65	17·91	22·50	21·50	16·16	15·66	16·70	10·90	*69*
September ..	19·95	17·14	21·00	19·00	15·39	14·39	15·20	10·80	*77*
October ..	17·25	16·58	20·00	19·50	14·83	13·43	16·30	11·70	*86*
November ..	17·90	16·04	19·75	20·50	14·79	13·14	16·40	12·00	*88*
December ..	19·15	15·49	19·75	21·50	14·49	12·73	16·00	11·50	*87*
January ..	20·05	14·87	19·75	22·50	13·87	12·38	16·35	10·60	*82*
February ..	19·90	15·89	19·75	22·50	14·89	13·45	17·60	11·55	*83*
March ..	21·05	15·83	19·75	22·50	14·83	13·60	17·70	11·35	*82*
April ..	20·15	15·15	19·75	22·50	14·40	13·10	17·15	10·75	*81*
May ..	18·55	14·49	19·75	21·50	13·74	12·47	16·20	10·15	*78*
June ..	18·55	14·93	19·75	21·50	14·18	12·85	16·10	10·35	*77*
July ..	18·80	15·23	19·75	21·50	14·23	13·00	16·00	10·50	*78*
1925–26.									
August ..	17·90	14·40	20·00	21·00	13·15	12·50	15·40	10·05	*83*
September ..	18·15	14·61	22·00	20·00	13·36	12·61	15·45	10·55	*82*
October ..	16·20	12·50	21·00	18·75	11·00	10·25	13·15	8·65	*84*
November ..	16·15	12·94	21·00	17·50	11·19	10·44	13·40	8·65	*87*
December ..	14·15	12·52	21·00	15·00	10·77	10·04	13·05	8·00	*78*
January ..	13·85	12·73	21·00	16·75	10·98	10·28	13·20	8·05	*76*
February ..	13·30	12·33	19·00	16·00	10·58	9·88	12·75	7·60	*74*
March ..	12·30	11·91	16·00	14·00	10·41	9·71	12·35	7·20	*71*
April ..	12·20	11·59	16·00	13·00	10·09	9·44	11·75	7·20	*73*
May.. ..	12·60	12·13	15·00	13·00	10·63	9·98	12·20	7·60	*74*
June ..	12·05	11·41	15·00	12·75	9·66	9·31	11·55	6·80	*71*
July.. ..	12·20	11·92	14·00	12·25	10·17	9·77	11·60	7·50	*75*
1926–27.									
August ..	12·60	11·17	12·50	11·75	10·17	9·87	11·50	7·70	*76*
September ..	12·25	9·48	12·00	12·25	8·48	8·18	9·90	6·55	*78*
October ..	10·50	8·15	11·50	10·50	7·15	6·80	8·50	5·50	*80*
November ..	10·10	8·22	10·75	10·25	7·22	6·87	8·70	5·65	*82*
December ..	9·80	8·20	9·50	10·00	7·20	6·80	8·60	5·75	*84*
January ..	10·10	8·51	9·50	10·00	7·26	7·01	8·95	5·95	*82*
February ..	10·80	8·92	9·50	10·25	7·67	7·42	9·90	6·40	*83*
March ..	10·45	8·86	9·00	10·50	7·86	7·36	10·00	6·30	*82*
April ..	11·60	9·30	9·75	10·75	8·55	8·05	10·95	6·95	*83*
May ..	13·10	9·89	9·25	12·00	9·14	8·64	11·55	7·45	*84*
June ..	13·30	10·08	9·50	12·50	9·33	8·83	11·80	7·70	*85*
July ..	15·10	11·05	10·00	14·25	10·30	9·80	13·30	8·50	*85*
1927–28.									
August ..	15·45	12·00	11·50	15·25	11·40	10·90	14·40	9·15	*82*

NOTES ON CURRENT LITERATURE

COTTON IN INDIA.

483. We have recently received a copy of the "Rev. of Agr. Operations in India, 1925-26." During the year under review, the area under cotton rose to 28,101,000 acres, as compared with 26,801,000 acres in 1924-25, the estimated yield being 6,075,000 bales. The average yield per acre was 86 lb. of ginned cotton, as compared with 91 lb. and 87 lb. in the two preceding years. The quantity of raw cotton exported was 4,173,400 bales of 400 lb., as compared with 3,326,400 bales in the previous year. The value of cotton goods exported was Rs. 9,65 lakhs.

The Cotton Transport Act continued to be of great value in the districts to which it was applied. Enquiry into the finance of the cotton crop was continued. No further progress was made with the organization of primary cotton markets. Substantial quantities of American cotton were imported, and precautions were taken against the danger of introducing boll weevil.

Further progress was made in the various lines of research being carried out, and some of the improved varieties of cotton produced were extended in cultivation.

484. Indian Central Cotton Committee. From the Press communiqué of the half-yearly meeting of the Committee held on July 18 last, we note that the Cotton Transport Act and the Ginning and Pressing Factories Act are working satisfactorily. The watering of cotton has again come into prominence, and pamphlets have been issued describing its ill effects (*cf.* Abstr. **542**). Marked progress has been made in research, and some of the new cottons give good promise of success. At the Technological Laboratory 659 spinning tests have now been carried out, about half of which have been on new cottons. Investigations into the financing of the cotton crop and for the improvement of cotton marketing conditions are being extended.

485. Report of the Indian Tariff Board (Cotton Textile Industry Enquiry), 1927. (Govt. of India Cent. Publication Branch, 8, Hastings Street, Calcutta.) A summary of conclusions and recommendations is given on p. 206 of Vol. I. The present depression in the cotton textile industry in India is largely put down to Japanese competition, helped by stabilization of the rupee at a time of falling prices, by over-capitalization, and by other causes. Depression, with the cry for protection, is most pronounced in Bombay and Ahmedabad. Protection, unless only to a very small degree, is not advocated, but it is proposed that a bounty be given upon the spinning of higher counts of yarn.

486. Faults in Indian Cotton. (Abstr. from *Int. Cott. Bull.*, vol. v., **4**, no. 20, 1927, p. 603.) The Royal Commission on Indian Agriculture, which is taking evidence in London, heard evidence recently from the Oldham Master Cotton Spinners' Association. Mr. James Littlewood, of the Royton Spinning Company, who appeared on behalf of the Association, put forward some suggestions for the improvement of the Indian cotton used by Lancashire spinners. He mentioned that almost 100,000 bales of this cotton are used annually in Lancashire.

Among the points made by Mr. Littlewood were the following: If the trade is to be expanded, attention in India should be concentrated on the cultivation of such varieties of cotton as can be substituted in English mills for American cotton. The style of cotton required is white or creamy in colour, good grade (*i.e.*, free from leaf, seed, neps, and stains), staple $1\frac{1}{16}$ in. to $1\frac{1}{8}$ in., with diameter of fibre similar to American, and packed to a density not higher than a standard 400-lb. bale.

487. New Railway in Cotton-Growing Area. (*Cotton*, July 30, 1927.) The Governor of Madras performed on June 29 the opening ceremony of the Virudhunagar-Tenkasi Railway. This railway runs into the heart of the black soil cotton districts of extreme South India, and the object of the line is to open a rich cotton-growing and thickly populated area whose outlet till now has been by road only. It is believed that this railway will afford adequate facilities for the marketing of cotton.

488. Index to Publications of the Imperial Department of Agriculture in India dealing with Cotton, 1906–1926. By W. J. Jenkins. (Indian Central Cotton Committee, Bombay.) A most useful classified list.

489. Koilpatti Experiment Station. (Abstr. from *Digest of Operations of Dpt. Agr., Madras*, April, 1927.) Describes the successful working of the practice of drill cultivation of cotton, and spacing experiments. It is stated that the station has now been handed over exclusively to the Cotton Specialist to serve as a cotton-breeding station. An Assistant Cotton Specialist, with the necessary trained staff, will carry on further improvements on the cottons of the Tinnevelly and Ramnad districts. Manurial trials and cultivation experiments will also be carried out.

490. Hagari Agricultural Station, The *Rpt. of the Hagari Agr. Station, Madras*, 1925-26, recently received, contains accounts of selection work, varietal trials, and spacing experiments.

COTTON IN THE EMPIRE (EXCLUDING INDIA).

491. ASIA: Ceylon. *Progress in the Development of Cotton and Other Crops in the Hambantota District.* By. G. Harbord. (Abstr. from *Trop. Agriculturist*, lxviii., **5**, 1927, p. 319.) Two new Experiment Stations have been established at Bataata and Middeniya to carry out experiments in the rotation of crops, and for the production of improved seed.

At the Main Cotton Experiment Station at Ambalantota tractor ploughing has proved very successful. The average yield of cotton was 3½ cwt. seed cotton per acre, and over fair-sized blocks, of 5-7 cwt. per acre. Varietal and spacing tests are being conducted, and improved seed, by mass selection and pedigree seed selection methods, is being raised.

492. *The Cotton Industry.* (Abstr. from *Trop. Agriculturist*, lxviii., **4**, 1927, p. 197.) At the Agricultural Conference at Peradeniya in March, the Governor of Ceylon, Sir Hugh Clifford, announced that the Legislative Council had been asked for funds to finance the cotton growers in the Southern Province during the existing low prices. He felt that the money would be well expended in helping an industry which in many parts of the world had proved to be of such enormous advantage to agricultural peasantries.

493. Iraq. *Cotton Prospects.* (Abstr. from Editorial in *Baghdad Times*, March 31, 1927.) The estimate of 3,500 bales for 1926 was just reached from an area of 14,000 acres. Cotton-growers, though profits have been reduced by the slump in prices, are continuing in the cultivation with but small reduction of acreage, and impressed by their example, farmers in other districts have decided to try cotton. Large quantities of seed have already been delivered, and except at Baqubah and Daltawah, the prospects are very satisfactory. Preparations are usually belated in these two districts, and possibly this accounts for the inferior results obtained. The response of the farmers in Hillah and Diwaniyah to the appeal made by their Mutasarrifs has been very satisfactory, and several new districts have been tapped by the extension of the railway to Kirkuk.

494. AFRICA. We are indebted to the proprietors of *East Africa* for a copy of the souvenir number of their Journal, containing some very interesting articles relating to the East African Colonies.

495. *Kenya and Uganda Railway Policy.* (Abstr. from *East Africa*, vol. iii., no. 139, 1927, p. 1088.) At a special meeting of the East African Section of the London Chamber of Commerce, held in May last, Mr. C. L. N. Felling, General Manager of the Kenya and Uganda Railway, said he hoped that by July the line would be through to Mbulamuti for traffic under construction conditions. They had authorized construction of the Tororo-Mbale-Soroti section. Under the present system there had been substantial savings on the cost of construction, and although the original idea was that the money provided would take them to Mbale only, they would now certainly get to Soroti on savings, and perhaps beyond. Construction to Kampala had been much discussed, and the Railway Council had now recommended the Jinja-Kampala route, on which, however, they could not start construction until the beginning of next year, as they could not get materials through before then. There would probably be a connection also between Jinja and Bukonte, or some other place on the Tororo-Mbulamuti line.

496. NIGERIA. From the *Ann. Gen. Rpt.* for 1926 (No. 1335), recently received, we learn that in Sokoto the amount of cotton seed purchased was nearly three times as much as the previous year. Owing, however, to the abnormally early cessation of the rains and to the fall in prices, it is not anticipated that the current cotton season will come up to expectations. The new ginnery at Gusau has been completed, and others are being erected by the British Cotton Growing Association at Karadua and Funtua. The farm opened by the Empire Cotton Growing Corporation at Daudawa has made good progress.

The experiments in the Zaria Province with the Guy-Roadless and Burford-Kegresse types of flexible motor tractors have proved fairly successful, and it is intended to test them during the coming season with trailers. The results of the trials have so far shown that, while there are still faults of design and construction which will have to be remedied before this new type of mechanical transport is finally proved, there is every reason to believe that it will eventually be of value in helping to solve the transport problem.

497. *Cotton Prospects.* Advices recently received from the Department of Agriculture are to the effect that in the Southern Provinces the purchases of native cotton for export this season amounted to 9,800 bales of 400 lbs., as against 9,085 bales for last season. The rises in price during the buying period were an important factor in causing the purchases to be so great. The total exports for the whole country for this season are estimated at 27,000 bales.

Planting has started in the Northern and Southern Provinces, and at the time of writing a start had been made well up to time, and nothing of a discouraging nature had been noted.

498. NYASALAND. *Railway surveys.* (Abstr. from *East Africa*, iii., **140**, 1927, p. 1143.) It is officially notified in Nyasaland that the Secretary of State for the Colonies has authorized the following surveys in connection with the proposed railway extensions in Nyasaland:

(*a*) A reconnaissance from Chiromo *via* the Shire Valley to Balakas, and of a branch from this line to the Sumbu coal area;

(*b*) Detailed survey from Blantyre to Fort Johnston *via* Balakas;

(*c*) Reconnaissance from Balakas in the direction of Domira Bay, with a reconnaissance from this line to the Lilongwe plateau.

499. *Transport.* (Abstr. from *East Afr.*, vol. iii., no. 144, 1927, p. 1277.) Nyasaland proposes to expend more than £20,000 on road development during the next twelve months.

500. SOUTH AFRICA. *Official Year Book of the Union*, No. 8, 1910-1925. The references to cotton relate mainly to the year 1924, and deal with chemical investigation, cultivation, exports, prices, etc.

501. Advices from Magut, Natal, are to the effect that in the Empangeni district a very good crop of cotton has been reaped on the whole, and the success this year may be ascribed to (*a*) heavier and more frequent rains, and (*b*) very little bollworm of any kind, and, according to many reports, no Sudan bollworm. Near the Tugela River, some growers have averaged 2,000 lbs. of seed cotton per acre. They attribute their success to fairly good rains and no bollworm, and practically no pests of any kind, possibly due to the fact that the flora further south, and particularly on the higher land where the Tugela cotton-growers are, does not include any host plants of the Sudan bollworm.

502. *Cotton Cultivation Progress.* (Abstr. from *MacDonald's Cotton Year Book*, 1926-27.) Dr. MacDonald states that during the past decade it has been clearly demonstrated that cotton is the finest drought-resisting crop for South Africa, and not only has it proved well adapted for dry land cultivation over extensive areas of the Middle and Low Veld regions, but it has also produced abundant crops in various districts under irrigation. He adds that it is encouraging to note from statistical records that in fifteen years the cotton production of the Union has risen from 13,623 lbs. to 8,152,559 lbs. per annum, or, to put it more practically, from a value of £540 to £350,000 per annum.

503. *Cotton.* (Abstr. from *Afr. Sugar and Cotton Jour.*, June, 1927, p. 27.) It is stated in the editorial that in Zululand, Swaziland, and the low veld of the Transvaal, the cotton crops this year have been good in most of the districts, including the Weenen settlements.

The highest price paid during the month was 12·40d. for cotton grown by Mr. G. T. S. Goulding on the south coast. This was very surprising, inasmuch as the price realized was for the first pick, and therefore not the best cotton, and also considering the fact that the south coast hitherto had been notable for sugar and bananas, and not for cotton. The writer is of opinion that further investigation work is needed before it will be possible to make a definite statement as to the most suitable climate for cotton production in South Africa.

504. ZULULAND. *Cotton Cultivation.* (Abstr. from *Afr. Sugar and Cot. Jour.*, i., 4, 1927, p. 27.) At the Third Annual General Meeting of the Members of the Zululand Co-operative Cotton and Agricultural Association, Limited, held in May at Empangeni, the Chairman, Major Anderson, stated that the Association had this season adopted the Improved Bancroft strain of cotton as the variety most suitable for the district. It was giving fairly good results, but they were still subject to the formidable pest of the Jassid. There was, however, great hope of overcoming it, a variety, known as Z.1., having been evolved, giving a most remarkable jassid-proof quality throughout the Transvaal and Natal. It was really jassid-proof, and if it kept up that quality, it would make a big difference to cotton-growing in South Africa. The Chairman paid a tribute to the investigators who had discovered the jassid-proof variety for them—the experts of the Empire Cotton Growing Corporation. It was not fully realized what these men were doing for South Africa. The Empire Cotton Growing Corporation was maintaining a staff of highly-qualified experts, probably the most highly qualified of their kind in the world, to experiment, under the direction of Mr. Milligan, not only in the most suitable kinds of cotton to recommend and propagate, but also the most suitable crops for rotation purposes to be cultivated in con-

junction with cotton. All the experts were agreed that cotton-growers should not rely upon the one crop. It was impossible to ensure that the cotton market would always remain at a profitable level, and there were bound to be occasional slumps, so the experts were also devoting their attention to the most suitable crops for the growers to go in for as a stand-by. Mr. Parsons, at Candover, was doing most useful work in that connection.

505. *Cotton Ginning*, 1926. (Abstr. from *Afr. Sugar and Cot. Jour.*, i., **4**, 1927, p. 21.) The total crop dealt with by the ginnery of the Zululand Co-operative Cotton and Agricultural Association in the 1926 season was 3,615 bales of seed cotton, weighing 1,796,269 lbs., which produced 1,206 bales of lint weighing a total of 549,293 lbs. and 1,193,613 lbs. of commercial seed. [*cf.* p. 337.]

506. *Cotton Prospects.* (Abstr. from *Afr. Sugar and Cotton Jour.*, vol. i., **3**, 1927, p. 31.) It is stated that during the month of June the staff of the Ginnery of the Zululand Co-operative Cotton Association at the Empangeni Rail were working at full pressure, endeavouring to cope with the amount of cotton that was coming in. The grading showed that the product was all of excellent quality. Over 2,000 wool-packs had been received at the time of writing, and the output promised to exceed that of the previous season. Some of the lint had already been sold at a payable figure in the neighbourhood of 9d. Growers were gradually confining themselves to the one variety of Improved Bancroft seed recommended by the Government experts.

507. SUDAN. *The Climate of the Southern Sudan in Relation to Cotton Growing.* By R. A. Wardle. (*Mem. and Proc. Manch. Lit. Phil. Soc.*, 1925-6, p. 59.)

508. TANGANYIKA. *Cotton Prospects.* (Abstr. from *Trade Rpt. for* 1926, p. 7, recently received.) The Director of Agriculture reports: "In regard to the 1927 crop, it is believed that natives will sow 85 per cent. of the quantity of seed sown by them last year, and non-natives 50 per cent. of their last year's sowings. This estimate is on the conservative side. It is not, of course, possible at this stage to form any idea of the growing conditions for the crop. Owing to closer control of distribution, whereby more thorough use is made of the seed, a favourable season should give an output much the same in quantity as that of 1926."

509. UGANDA. A report received from H.M. Eastern African Dependencies' Trade and Information Office states that delayed rains are holding up cotton planting in some parts, but generally there is every indication of an increase in the total area planted.

510. *Prospects for* 1927-28 *Season.* (Abstr. from a report received from the Dept. of Overseas Trade, August, 1927.) Active propaganda has been carried out with a view to encouraging the natives to plant up extended areas in all suitable districts, and to stimulate their interest in the cotton industry generally. There has been a big demand for seed for sowing, and increased acreages are anticipated.

511. *Cotton Prospects.* (Abstr. from *East Africa*, iii., **140**, 1927, p. 1130.) In spite of the fact that last year Uganda's cotton crop was affected by weather conditions and the fall in prices, there is no reason to doubt that cotton-growing will continue to expand in the Protectorate, though the same great increases of acreage planted as have taken place in the past cannot be expected. On the other hand, the work of the Agricultural Research Department in plant and seed selection, and the constant advice and help of the various officers, are already showing results in the form of larger yields per acre in certain districts, and it is asserted that in a very short time sufficient selected seed will be grown to distribute over the greater part of the dependency. The quality of the crop is

becoming more uniform, and legislation has been introduced to prevent the carelessness of packing which has sometimes been evident in the past.

512. *Cotton Cultivation.* (Abstr. from *The Standard*, Nairobi, 11/6/1927.) Reports from all over the country are unanimous that more cotton is being planted this year than ever before. Uganda should be confident in looking forward to a better season in 1928, always, of course, given the necessary weather conditions during the next six months. The native has undoubtedly learned this year that his degree of wealth varies according to the amount of cotton he plants. He is suffering now partly because of short planting, and partly owing to the adverse weather conditions of 1926, but he appears to be taking no chances for next season, and if the climatic conditions are kind, he should be in a strong position in the early part of 1928.

513. *Cotton Seed.* (Abstr. from a report received from the Dept. of Overseas Trade, August, 1927.) "With the increase of 'crude oil' engines, the use of cotton seed as fuel will decrease in Uganda, thus making larger quantities available for export. Increased transport facilities will also tend to add to the exports of cotton seed. Whereas formerly a radius of about 40 miles from a port of shipment used to be considered the limit for the export of cotton seed to be a paying proposition, it is noted that this commodity has been exported this season from far greater distances."

514. *Ploughs in Uganda.* (Abstr. from *East Africa*, vol. iii., No. 148, 1927, p. 1377.) It is stated on good authority that no less than 2,710 ploughs are now in use by natives in the Teso district of Uganda.

515. *Carrying Uganda Cotton to Market.* (Abstr. from *East Afr.*, vol. iii., No. 139, 1927, p. 1100.) An official report on cotton in the Busoga area of Uganda states that "the outstanding feature this season is the number of light motor trucks plying for hire, especially in the Kamuli area. It can safely be said that not 5 per cent. of the natives in the latter area carry their cotton to the marketing centre. The full bags are carried from the village to the roadside, where the grower sits down and waits for a truck to come along. The trucks are owned by Indians and natives, and the rate charged is roughly 1*s.* per bag for distances varying from three to eight miles. The owner of the cotton is carried free. This system may be open to abuse, but it has certainly helped to get the cotton moving, and the growers appear to be quite satisfied."

516. AUSTRALIA: QUEENSLAND. *Cotton in Queensland.* (Abstr. from a letter recently received from Mr. W. G. Wells, the Cotton Specialist.) "The character of this season's cotton will be good, the body and strength of the fibres of what cotton I have seen being decidedly better than the average of any previous crops. As the rains have been so general, and have lasted over such a period, the subsoil moisture has been restored. This should have a beneficial effect on the quality of next season's crop, and should also be conducive to producing heavy yields. The young plants growing on a moist subsoil will quickly make connections with the lower moistures, and thus will be able to develop through the dry periods of October and November."

517. WEST INDIES: ST. VINCENT. A note received from the Agricultural Superintendent on the cotton crop for the quarter ended June 30, states that the planting of the 1927-28 Sea Island crop commenced in the middle of June, and on the whole the germination of seed had been good. The amount of Sea Island cotton produced during the past season was 507,240 lbs. of lint from 6,156 acres, a yield of some 82 lb. per acre. This indifferent return was due to repeated attacks from cotton caterpillars. It is anticipated that the area under this type of cotton will be reduced during the coming season.

(And *cf.* Nos. 544, 545.)

COTTON IN EGYPT.

518. The Official Report of the International Cotton Congress, Egypt, 1927. The resolutions of the Congress have already been given in Abstract 194 in April, but the complete volume, recently received, contains various papers of interest outside of Egypt—*e.g.*, on the destruction of Pink Bollworm, on mixed varieties, on defects in yarn, etc., and the Report is furnished with a number of excellent illustrations depicting cotton cultivation in Egypt.

519. New Cotton Spinning Scheme. (Abstr. from *Br. Cham. of Com. of Egypt, Monthly Journal*, vol. xiv., **6,** 1927, p. 81.) It is stated in the *Egyptian Mail* that the Department of Commerce and Industries has received an application by a great American spinning and weaving company, asking it to make representations on its behalf to the Ministry of Finance for the obtaining of a large plot of Government land on the coast of the Mediterranean, on which to build a large cotton-spinning factory, and thus to create a new industry in the country. The capital to be invested in this undertaking is estimated at five million dollars.

520. Proposed Law forbidding Sales of Cotton "on Call." (Abstr. from *Br. Cham. of Com. of Egypt, Monthly Journal*, xiv., No. 7, 1927, p. 96.) We learn from the *Egyptian Mail* that the General Assembly of the Mixed Court of Appeal has refused to approve the new law framed by the Egyptian Government with a view to putting an end to the system under which cotton is sold "on call," for the reason that it would interfere with the liberty of trade. The proposed law, which was, of course, approved by the Legislative Committee before being sent to the Mixed Courts, has, therefore, been referred back to the Ministry of Finance for further consideration and amendment.

As may be recalled, this Law prohibits the sale of any cotton, either before or after it has reached maturity, at a price to be fixed later, on the basis of the price then current in the Futures market.

(And *cf.* Nos. 575, 601.)

COTTON IN THE UNITED STATES.

521. Farming for Profits. By W. C. Jensen. (*Bull.* 230, *Clemson Agr. Coll.*, S. Carolina, 1926.) An economic study, with curves and graphs, of production and costs in the Anderson area of South Carolina. The mean cost of producing cotton in 1924 is given at 12·5–17·5 cents a pound, and the average production is about half a bale an acre. The average man hours per acre of cotton are given at 118, mule hours at 58, and use of machinery at 58. The total cost of cotton production on one acre is $42·72 reduced to $34·35 by the by-products, and finally increased to $41·05 by rent and interest. The net return per acre averages $22·92.

522. A Study of Economic Conditions in the Lexington-Batesburg Section of South Carolina. By B. A. Russell. (*Bull.* 233, *S. Carolina Agr. Exp. Sta.*, 1926.)

523. A Report on Investigations of Farm Problems. (*Biennial Rpt. o Oklahoma Agr. Exp. Sta.*, 1924-1926.)

524. The Influence of Cotton Prices on American Section Markets, and the Reconstruction necessary for Trade Recovery. By E. E. Canney. (*J. of Text. Inst.*, xviii., **7,** 1927, p. 161.)

525. The Marketing Problem: How it is being tackled in U.S.A. By E. T. Elbourne (1926). In the foreword of this book, Sir Josiah Stamp points out that until recently attention was focussed on production only, and when articles were made, economists and industrialists almost lost interest in them. Now it is realized more fully that a product is economically valueless until it gets into the place where it can be properly used, and into the hands of a final user, and that these stages are just as important for the study of the total cost of production as the factory stages. In this book the application of marketing to manufactured products is dealt with, and useful information is given regarding the publications of the United States Government Department which corresponds closely to the British Board of Trade. Chapters are devoted to the estimation of waste, advertising, budgetary control, marketing, surveys, and distribution; a list of books on marketing is appended.

526. The U.S. Government and the Cotton Farmer. By Dr. H. Parker Willis. (Abstr. from *Int. Cot. Bull.*, vol. v., **4**, No. 20, 1927, p. 562.) An important paper dealing with the Government crop forecasts, cotton farmers' financial facilities, and the policy advocated by the McNary-Haugen Bill.

527. Community Production of Acala Cotton in the Coachella Valley of California. By H. G. McKeever. (*U.S. Dpt. Agr. Bull.*, 1467, 1927.) Describes the development of an actual one-variety community from a mixed-variety condition, enumerates the difficulties encountered, and the way in which they were surmounted. Among the necessities for establishing a one-variety community are the following: the growing of superior seed; its sale at cost price; the choice of a first-rate variety of cotton (so that its superiority can be easily shown); refusal by the ginneries of cotton of other varieties; protective legislation, etc.

528. The Cotton Textile Institute, United States. (Abstr. from *Text. Rec.*, xlv., **532**, 1927, p. 92.) Formed to assist manufacturers of cotton goods, the Cotton Textile Institute is beginning to function. Already several groups have been formed which are dealing with the question of various classes of manufacture. Cost accounting is being seriously tackled, together with investigation into discovering new uses for cotton fabrics.

529. Sledded Cotton. (*Text. Rec.*, xlv., **530**, 1927, p. 41.) In an American mill of over 100,000 spindles, it was recently noticed that an unusual number of ends were breaking down in the spinning room, and on investigation it was found that 32 per cent. of the breaks were due to the inclusion of shredded bark from the cotton stalks, especially that from the stem of the cotton boll. The cotton was purchased as low grade, but not as sledded cotton.

It is stated that the practice of sledding cotton reduces the percentage of Middling and above, and there is no doubt that the present high premium for good grades is due to the fact that much cotton that would have been Middling and above was, by sledding, reduced to low grades.

530. Sledded Cotton. By W. Whittam. (*Text. Rec.*, xlv., **531**, 1927, p. 132.) The American Cotton Manufacturers Association, at its recent convention, adopted a resolution to petition Congress to authorize the Department of Agriculture to specify separately in its crop report and estimates the numbers of "sledded" or "snapped" bales from those which are properly picked.

531. Snapped Cotton: Spinning Tests. (*Nat. Assoc. Cotton Mfrs. Bull.* No. 80, 1926. Abstr. from *J. of Text. Inst.*, xviii., **7**, 1927, A. 248.) An extract from a report of an American official preliminary test on the comparative spinning properties of picked and snapped cottons gives tables of (1) staples and waste percentages of Oklahoma and Texas 1925 cottons, and (2) breaking loads of yarns spun therefrom.

COTTON IN FOREIGN COUNTRIES.

532. ARGENTINA. *Cotton Cultivation.* (Abstr. from *S. Am. Journal*, April 23, 1927.) The total area planted to cotton for the 1926-27 season has been calculated at 71,746 hectares. This total is equivalent to 65·2 per cent. of the area planted last year, but is 113·6 per cent. compared with the annual average for the five-year period 1921-22 to 1925-26.

533. COTTON IN THE BELGIAN CONGO. A report received from the Dept. of Overseas Trade states that 600 tons of unginned cotton were produced last year, and it is expected that this output will be increased during the next few years until a crop of some 15,000 tons is anticipated for 1930.

534. BRAZIL. The Brazil Number of *The Times* of June 21, 1927, contains a detailed account of the country and its various industries, agricultural and manufacturing, including cotton.

535. COTTON IN BRAZIL. (*Text. Rec.*, xlv., **531,** 1927, p. 135.)

536. We have received from the Association Cotonnière Coloniale a copy of Bulletin No. 79, containing much information regarding cotton in the French Colonies.

537. CULTURE DU COTONNIER DANS LES COLONIES FRANÇAISES. (*La Nature*, Paris, 1927, No. 1754. Abstr. in *Int. Rev. of the Science and Practice of Agr.*, Rome, xviii., **3,** 1927, p. 152-T.)

538. LE COTON A MADAGASCAR. By V. Cayla. (*Agron. colon.*, Nos. 109 and 110, 1927. Abstr. from *Rev. App. Ent.*, xv., Ser. A., **3,** 1927, p. 224.) Cotton is not grown to any extent in Madagascar, the natives merely producing enough for their own wants. The possibilities of cotton-growing in the island are, however, far from negligible, though pests cause considerable damage, and labour and transport difficulties are great.

539. COTTON CULTIVATION IN NORTH AFRICA. By H. Erhart. (*Bull. Soc. Ind. Mulhouse*, 1927, **93.** Abstr. in *Summ. of Curr. Lit.*, vii., **13,** 1927, E. 40.)

540. COTTON PRODUCTION IN PARAGUAY. (Abstr. from *Int. Cot. Bull.*, v., **4,** No. 20, 1927, p. 544.) The cotton production in Paraguay this year is estimated by the Ministry of Agriculture to be 7,678,670 kilos, or say 120,000 bales, a slight increase on last year.

541. SPAIN. *Cotton Cultivation.* (Abstr. from *Coml. Oldham*, i., **10,** 1927, p. 17.) An article reprinted from *El Commercio Hispano-Britanico*, giving costs, production, selling price, and value of cotton in Spain.

CULTIVATION AND MACHINERY; IRRIGATION, ETC.

542. THE EFFECT OF WATERING ON COTTON. A pamphlet issued by the Indian Central Cotton Committee, in June last, as a warning against the practice of watering cotton at the time of pressing, which has been revived in some parts of India during the present year. It is stated (i.) that compressing wet cotton to high density either increases the percentage of waste, or reduces the breaking strength of the yarn, or may do both; (ii.) that in wet storage, micro-organisms of various kinds can attack the cotton hair to a much greater extent.

The Central Cotton Committee, in bringing these facts to the notice of the cotton farmer, points out that if the intrinsic value of Indian cotton is reduced by faulty handling or by malpractices, the inevitable result will be a general economic loss to the country, and also lower prices to the cotton-grower.

543. THE INFLUENCE OF POTASH ON COTTON BOLLS AND FOLIAGE ON A POTASH DEFICIENT SOIL. By J. J. Skinner and W. F. Pate. (*Jour. Amer. Soc. Agron.*, xvii., **9**, 1925. Abstr. in *Exp. Sta. Rec.*, lvi., **4**, 1927, p. 323.)

544. COTTON CLASSING. By L. L. Gudge. (Abstr. from *Queensland Agr. Jour.*, xxvii., **6**, 1927, p. 525.) An excellent account of the methods of grading and classing cottons in Queensland given under the following heads: Cause of varying grades and staples; the universal standards; the grading of Queensland seed cotton; description of present seed cotton grades; method of classing and receiving at the ginnery; notes for growers.

545. THE CLASSING OF QUEENSLAND COTTON CROPS, 1919-1926. By L. L. Gudge. (*Queensland Agr. Jour.*, xxvii., **6**, 1927, p. 518.)

546. CROP ROTATIONS FOR THE COASTAL PLAIN SECTION OF NORTH CAROLINA. By E. C. Blair. (Abstr. from *Extn. Circ.* No. 165, 1927, *N. Carolina State Coll. of Agr. and Eng.*) An account of various three-year rotations employed. In view of the present interest of the subject, we quote in brief the following in relation to cotton:

(*a*) 1. Corn with soybeans or velvet beans.
2. Spring oats with lespedeza or soybeans.
3. Cotton, Abruzzi rye, and vetch or crimson clover.

(*b*) 1. Corn with soybeans or velvet beans.
2. Cotton, Abruzzi rye, and vetch or crimson clover.
3. Soybeans or peanuts, Abruzzi rye and vetch.

(*c*) 1. Corn with soybeans or velvet beans, Abruzzi rye.
2. Soybeans or peanuts.
3. Cotton, Abruzzi rye, and vetch or crimson clover.

(*d*) 1. Corn, with soybeans or velvet beans.
2. Cotton, Abruzzi rye, and vetch or crimson clover.
3. Soybeans, oats and vetch.
4. Oats and vetch, lespedeza or soybeans.
5. Cotton, Abruzzi rye, and vetch or crimson clover.
(This last may be omitted, leaving a four-year rotation.)

(*e*) This rotation has proved especially satisfactory on a large cotton farm worked entirely by tenants.
1. Corn with soybeans planted thick.
2. Cotton.
3. Cotton.

(*f*) 1. Tobacco, Abruzzi rye, and vetch or crimson clover.
2. Corn with velvet beans.
3. Cotton and Abruzzi rye.

547. THE EFFECT OF APPLICATIONS OF CYANAMID ON THE NITRATE CONTENT OF FIELD SOILS. By F. E. Allison. (*J. of Agr. Res. U.S.*, xxxiv., **7**, 1927, p. 657.) Experiments are reported which show that cyanamid greatly retards nitrification in soils, thus explaining partially, at least, why in previous experiments cyanamid was not a satisfactory fertilizer for cotton. These experiments with soil samples taken from the field where the cotton was growing show that this crop had a smaller nitrate supply available when fertilized with cyanamid than did the cotton on the control plots. Doubtless the presence of certain decomposition products of the cyanamid play a part also. These decomposition products act in some cases as direct plant poisons, and in others merely as poisons for the nitrifying bacteria.

548. COTTONSEED. DETERIORATION BY MOISTURE. By J. Malowan. (*Oil and Fat Ind.*, **4**, 1927. Abstr. from *Summ. of Curr. Lit.*, vol. vii., **10**, 1927, A. 18.)

The deteriorating effect of excess moisture on cottonseed, either in the field or in storage, is a serious problem from the seed-crusher's point of view. Deteriorated seed cannot be improved, nor can good oil and press cake be manufactured from it. Field damaged seed still has the prime colour, whilst storage damaged seed is discoloured. Both kinds of seed yield oil higher in free fatty acids than prime seed. There is at present no way by which mills can conveniently determine whether seed is prime or field damaged. When damp seed is stored, the temperature of the pile rises rapidly, and may increase 50-60 degrees in a few days. The danger region for moisture is about 10 per cent., but conditions will determine whether seed with this moisture content will heat or not. Seed with less than 10 per cent. rarely heats, and with more than 12 per cent. must be kept cool to prevent heating. Heating of seed is caused by enzymes, oxidation being the most important chemical process taking place. The sugars are first used up, then the pentosans are attacked. The physical and chemical characters of the oils and proteins change. Methods of control are discussed, but a really satisfactory method of preventing seed from heating has still to be found.

549. AN IMPROVED METHOD OF DELINTING COTTON SEED WITH SULPHURIC ACID. By C. D. Sherbakoff. (*Tennessee Sta. Circ.*, **3**, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **5**, 1927, p. 435.) The author found that cotton seed could be delinted by the application of 1 part by volume of concentrated commercial sulphuric acid to 17 of seed, saving about 60 per cent. of acid as compared with the original method. Delinting can also be accomplished with acid diluted 1 part to 5 of water for 60 parts by volume of cotton seed, seed being delinted in about five days. Procedure is outlined.

550. ACID DELINTING OF COTTON SEED. (*49th Ann. Rpt. of N. Carolina*, 1926, p. 61.) In tests carried out on the acid delinting of cotton seed as a measure of control against anthracnose and bacterial boll rot (*Bacterium malvacearum*), it was shown that working at ordinary temperatures of 65° or 75° F., very good delinting may be obtained in ten minutes with commercial acid of 66° Baumé strength. Under the same conditions, but with acid of 52° Baumé, delinting does not occur even though the treatment lasts for hours, and one uses a small quantity of seed in a relatively large quantity of acid (excess of acid). With 58° acid delinting is poor. When 60 and 61° acid is used, the treatment must be continued for sixty minutes, and even then delinting is only fair to good in character. If one maintains the seed and acid at a temperature of 120° to 130° F. during the treatment, acid of 53° Baumé will delint seed perfectly in ten minutes. The difficulty of maintaining this temperature will add to the trouble and expense of the treatment to such an extent as to more than offset the lower price of the low grade acid. Moreover, 66° acid will delint considerably more seed in a given time than acid of a lower concentration. The saving in the quantity of acid required, the greater completeness of delinting and economy of time makes it advisable to use 66° acid whenever acid of this strength can be obtained.

Tests on the quantity of acid required showed that two quarts of acid will delint one bushel of seed in ten minutes. It is probable that the least quantity of acid required to delint one bushel of seed is even less than two quarts; but in practice it will be found advantageous to use two and one-half or three quarts of acid per bushel of seed. This is because of the mechanical difficulty encountered in stirring so large a volume of seed into so small a volume of acid thoroughly enough to coat every seed with acid.

With 66° acid delinting is usually complete in ten to fifteen minutes. In certain tests the seed were left in such acid for twenty to twenty-four hours. In every instance, seed so treated germinated as well as or better than the untreated checks.

551. Fertilizing Cotton in the Piedmont Region of Georgia. (*Press Bull.* 238, 1926.) At the Georgia Experiment Station experiments have been conducted for a number of years to determine the best fertilizer for cotton. The South Carolina and Alabama Experiment Stations have run similar experiments, which check very closely with those at this Station, as far as they can be compared. Based on these results, the following recommendation is made for fertilizing an acre of cotton on the average Piedmont soil:

500 lbs. acid phosphate.
75 lbs. ammonium sulphate.
100 lbs. sodium nitrate.
25 lbs. muriate of potash.
100 lbs. dry sand or dirt.

200 lbs. of sodium nitrate may be used instead of the 75 lbs. of ammonium sulphate and 100 lbs. of sodium nitrate. One hundred lbs. of kainit may be used instead of 25 lbs. of muriate of potash.

552. Cotton in Louisiana. (Abstr. from *Ann. Rpt. of Agr. Exp. Stations*, 1926.) Accounts are given of rotation, breeding, spacing, and fertilization experiments, and investigations into pest control.

553. Cotton Experiments, 1926. By E. B. Ferris. (*Cir. No.* 69, 1926, *A. and M. Coll., Miss. Agr. Exp. Sta.*)

554. Cotton Fertilizers and Varieties. By J. F. O'Kelly *et al.* (*Bull. No.* 241, 1926, *A. and M. Coll. Miss. Agr. Exp. Sta.*)

555. Report of the Holly Springs Branch Experiment Station, 1926. By C. T. Ames. (*Bull.* 239, 1926, *Miss. Agr. Exp. Sta.*) Cotton variety tests, spacing tests, and fertilizer tests are described.

556. Rpt. of the Raymond Branch Experiment Station, Mississippi, 1926. By H. F. Wallace. (*Bull.* 240, 1926, *Miss. Agr. Exp. Sta.*) Gives the results of cotton variety tests, fertilizer and spacing tests, and average results of nitrogen sources test.

557. Cotton Investigations in North Carolina. (Forty-ninth *Ann. Rpt.*, 1926.) The further progress of experiments with cotton is described under the following heads: Fertilizer experiments; crop rotations; research into the effect of storage of seed cotton upon certain chemical and physical qualities of the fibres; studies of the inheritance of the fuzzy seed coat of cotton, and its relation to lint production; research on some factors which influence the development of cotton fibre cell wall; investigations into the value of cottonseed meal as food for cattle.

558. Fertilizer Experiments with Cotton. By C. B. Williams *et al.* (*Bull. No.* 250, *N. Carolina State Coll. of Agr. and Eng.*, 1926.) Shows the effect of different analyses, quantity per acre, and nitrogen sources upon yield and maturity of the cotton crop.

559. Fertilizer Experiments. (*S. Carolina Sta. Rpt.*, 1926, Abstr. from *Exp. Sta. Rec.*, 56, **6**, 1927, p. 529.) The results of experiments on the time of applying nitrogenous fertilizers showed that the greatest yield increase occurred where 50 lbs. of sodium nitrate was supplied at chopping, and 50 lbs. when the first squares formed. Addition of 100 lbs. of sodium nitrate when the first squares began to form was next in effectiveness. The fertilizer experiments as a whole recommend for cotton in the coastal plain of South Carolina, 600 to 800 lbs. per acre of fertilizer containing 9 to 12 per cent. of acid phosphate, 3 to 5 of ammonia, and 3 to 4 of potash, with 150 lbs. of sodium nitrate, or 110 lbs. of ammonium

sulphate as a side application. For the Piedmont, 600 to 800 lbs. of fertilizer analyzing 10 to 12 per cent. phosphoric acid, 3 to 5 of ammonia, and 2 to 3 per cent. of potash is indicated, with the same top dressing as for Coastal Plain soils. Cover crop experiments indicated that land can be rapidly improved, and planted to cotton each year, provided a good cover crop of rye or vetch is produced each winter and turned under. Where rotation is practised, and a legume follows small grain, the land is improved more rapidly.

560. SPACING EXPERIMENTS. (*S. Carolina Sta. Rpt.*, 1926. Abstr. from *Exp. Sta. Rec.*, 56, No. 6, 1927, p. 528.) In spacing experiments involving Cleveland, Dixie Triumph, and Carolina Foster, the increased earliness due to close spacing was found about equal in the varieties, although they differed somewhat in their growth habits. The difference in earliness was also apparent in the acre yields of seed cotton. The maximum yields in practically every case were produced with 6-inch spacing, although yields from 6, 9, and 12-inch spacing differed little. In further hill-spacing tests, an increase in earliness and generally an increased yield came from a larger number of plants per hill. Continued recommendations are that cotton should be spaced to average about one stalk every 6 inches in the 4-foot row, providing for about 21,000 plants per acre.

561. THE "SEGUNDO" DEFIBRATING MACHINE. (Abstr. from *Int. Cot. Bull.*, vol. v., **4**, No. 20, 1927, p. 632.) Several improvements have lately been made in the construction of this machine, the output is largely increased, the floor space reduced, and the moving parts have been simplified.

DISEASES, PESTS, AND INJURIES, AND THEIR TREATMENT.

562. DISEASES AND PESTS OF COTTON IN EGYPT. By C. B. Williams. (Abstr. from the *Egyptian Cotton Number* of the *Manch. Guard. Coml.*, March 17, 1927, p. 24.) The most important pests and diseases mentioned in this summary are as follows:

1. Attacking the seedling plant:
   - (*a*) Sore-shin disease.
   - (*b*) Cut Worm (*Agrotis ypsilon*).
2. Attacking the leaves, stem, or root system of the growing plant, and so reducing its vigour:
   - (*c*) Cotton-leaf Worm (*Prodenia litura*).
   - (*d*) Wilt disease (*Fusarium*).
3. Attacking the boll and so reducing the yield of lint:
   - (*e*) Pink Bollworm (*Gelechia gossypiella*).
   - (*f*) Common Bollworm (*Earias insulana*).
   - (*g*) Sucking Bugs (*Creontiades*, etc.).
   - (*h*) Black Fungus (*Rhizopus*).

In addition to the above, the following insects and diseases occur, usually on a small scale, but sometimes breaking out locally into serious proportions: Aphis, thrips, stem-borers, and the leaf-spot fungus.

563. PEST DESTRUCTION BY AEROPLANE. By A. E. Blake. (*Sci. Progress*, xxi., **84**, 1927. Abstr. in *Rev. Appl. Ent.*, xv., Ser. A., Pt. 7, 1927, p. 339.)

564. WHAT ARE THE PESTS OF COTTON, AND HOW CAN THEY BE CONTROLLED? (In Russian.) By Z. S. Rodionov. (Abstr. from *Rev. Appl. Ent.*, xv., Ser. A., Pt. 6, 1927, p. 314.) This is a popular account of cotton pests in Transcaucasia. They are dealt with under their popular names, and arranged according to the type of injury.

565. Report of the Sub-Committee on Insecticide Machinery. (*J. Econ. Ent.*, xx., 1, 1927. Abstr. from *Rev. Appl. Ent.*, xv., A. 5, 1927, p. 265.) The evolution of spraying machinery is reviewed. A self-mixing duster and stationary spray outfits are described, as well as a new type of sprayer called the "liquid duster," which applies a liquid spray in the same manner as dust is ordinarily blown on to the foliage. The economics of spraying operations and the standardization of spray machinery are discussed.

566. A Method for the Approximate Calculation of the Progress of Introduced Parasites of Insect Pests. By W. R. Thompson. (*Bull. Ent. Res.*, xvii., 3. London, 1927. Abstr. from *Rev. Appl. Ent.*, xv., A. 5, 1927, p. 239.) This paper shows how the mathematical method previously discussed (R.A.E., x., A., 386, 519; xiv., 568) may be of practical value in determining approximately the length of time, at any given moment, that must still elapse before the final subjugation of an insect pest by an introduced parasite. The original formulæ, which are based on such factors as the initial numbers of parasites and hosts, and the ratio between their effective rates of production, are modified in order to afford a rough estimate when the only data available are the initial number of parasites liberated, and the percentage of infested hosts at the time the calculations are undertaken.

567. The Parasite "Zoo." Scientific Attack on the Insect Pests of the Empire. In *The Times* of June 6, an announcement is made of the opening of a laboratory for the breeding of "beneficial parasites" at Farnborough Royal, Buckinghamshire. The laboratory is under the direction of Dr. Marshall and Dr. Neave of the Imperial Bureau of Entomology, and has been established by a grant from the Empire Marketing Board.

The function of this "Parasite Zoo" is to discover, breed, and despatch over the Empire the parasites which keep down the numbers of harmful insects. As agriculture spreads in the more sparsely settled areas in the Colonies and Dependencies so undoubtedly will increase the losses due to insect pests, unless much more adequate measures are taken for their control than has hitherto been the case. The "Zoo" is the first institution of its kind in the Empire. It is a wise investment.

568. Cotton Pests.—II. By L. A. de Azevedo Marques. (*Bol. Minist. Agr. Ind. e Comm.*, xv., (ii.), no. 6, Rio de Janeiro, 1926. Abstr. from *Rev. Appl. Ent.*, xv., Ser. A., 5, 1927, p. 209.) Describes *Alabama argillacea*, Hb., which is a pest of cotton in Brazil.

569. Pragas do Algodoeiro.—III. (Cotton Pests.—III.) By L. A. de Azevedo Marques. (*Bol. Min. Agr. Ind. e Comm.*, xvi., (i.), No. 1, 1927. Abstr. in *Rev. Appl. Ent.*, vol. xv., Ser. A., Pt. 6, 1927, p. 308.)

570. Injurious Insects and Other Animals in U.S.S.R. in the Years 1921-1924. Parts 1 and 2, by I. N. Filipjev; Part 3 by B. Vinogradov and S. Obolensky. (Issued by the State Institute of Experimental Agronomy, Bureau of Applied Entomology, Leningrad, 1926.)

571. Some Insects Associated with Cotton in Papua and the Mandated Territory of New Guinea. By E. Ballard. (Reprinted from the *Bull. of Ent. Res.*, xvii., 3, 1927.) Among the insects recorded are the following, with some notes on their distribution and behaviour: Pink Bollworm (*Platyedra gossypiella*), *Earias fabia*, *Heliothis obsoleta*, Jassid (*Empoasca*), *Conogethes punctiferalis*, and various species of Cotton Stainer.

572. Les Insectes nuisibles au cotonnier en Afrique Occidentale Française. By P. Vayssière and J. Mimeur. (Obtainable from Librairie Emile

Larose, Rue Victor-Cousin, 11, Paris V^e.) An excellent and well-illustrated account of the many insects harmful to cotton, which should be in the hands of entomological workers in Africa.

573. Boll Weevil Control Tests. (*Georgia Coastal Plain Sta. Bull.* 6, 1926. Abstr. in *Exp. Sta. Rec.*, 56, **6**, 1927, p. 558.) In a brief reference to control work conducted, it is pointed out that the work has shown conclusively the benefits of early poisoning.

574. The Mexican Cotton Boll Weevil. By W. Newell *et al.* (*Bull.* 180, 1926. *Agr. Exp. Sta., Gainesville, Florida.*) A general account of the weevil, its life-history, and of poisoning methods.

575. Destruction du ver rose dans les graines de coton en Egypte. By C. B. Williams. (*Bull. Union Agr. Egypte*, xxv., **178**, 1927. Abstr. from *Rev. Appl. Ent.*, xv., Ser. A., **3**, 1927, p. 223.) *Platyedra* (*Gelechia*) *gossypiella*, Saund. (Pink Bollworm) is the most serious cotton pest of Egypt, causing an annual loss of some 10 to 30 per cent. of the crop, or an equivalent of about £10,000,000. It is hoped that the infestation has now reached its maximum, for it does not seem to have intensified during the last eight or ten years. The development of remedial measures is traced from the beginning up to the year 1926, when over 130 ginning machines of the Simons or Delta type, which include devices by which the seed is brought in contact with metal surfaces heated by steam, have been established. The method of inspection that ensures the carrying out of these remedies satisfactorily is explained. At present, all sweepings of seed have to be burnt, but experiments are being made with a view to devising a machine that will treat these by heat very cheaply.

576. The South American Bollworm of Cotton (*Sacadodes pyralis*, Dyar). By C. L. Withycombe. (Reprinted from the *Bull. of Ent. Res.*, xvii., **3**, 1927.) *Sacadodes* is closely allied to *Diparopsis castanea*, Hampson. The moths appear at, or soon after, sundown, and each female lays at least 100 eggs. The larva attacks a boll, or, if this is not available, a bud or flower, but one of these does not supply sufficient food for it to reach maturity. The attack on a boll is usually made under the shelter of the bracts. The larva attains full growth (about 3 cm. long) in about fifteen days, and passes about three weeks in the pupal stage. Cotton is the normal food, and parasites appear negligible. Cultural methods of control are called for.

577. Cotton Pests. (*Arkansas Sta. Bull.*, 215, 1926. Abstr. from *Exp. Sta. Rec.*, 56, **4**, 1927, p. 355.) The insect injury to cotton which attracted most attention at the Arkansas Station during 1926 was caused by three species of plant bugs: the cotton hopper, the tarnished plant bug, and the cotton leaf bug. A survey made at representative points in the State at the height of the outbreak showed that the majority of all infestations of the cotton hopper could be traced to patches of croton, or of evening primrose. These infestations were generally local, although in some instances they were spread over the greater part of large plantations. Dusting cotton with both sublimed and superfine sulphur gave fairly satisfactory control of the hopper in experimental plats, and was also apparently successful in large fields where used by the growers.

578. Recent Work on Some Pests of Economic Crops. By J. C. Hutson. (Abstr. from *Trop. Agriculturist*, lxviii., **4**, 1927, p. 220.) Reference is made to two leaf-eating caterpillars of cotton, *Cosmophila erosa* and *Sylepta deroguta*, which cause trouble in the early stages of new areas of cotton in Ceylon.

579. Cotton Pests in Texas. (*Texas Agr. Exp. Sta., Thirty-ninth Ann. Rpt.*, 1926. Abstr. from *Rev. Appl. Ent.*, vol. xv., Ser. A., Pt. 6, 1927, p. 306.)

Aphis gossypii, Glov. Continuing previous studies on *Aphis gossypii*, Glov., on cotton, 54 generations were reared during the year, of which 3 per cent. were winged forms; these occurred in only 6 of the generations, and in each case crowding had taken place. Isolations were made from 8 different generations, and the individuals developing in each were allowed to become crowded; in every case winged forms appeared, whether temperature was high or low, as long as it was sufficiently high to permit reproduction. Winged or wingless forms can, in fact, be produced at will by permitting or preventing a crowded condition.

Cotton Flea Hopper (*Psallus seriatus*, Reut.). Some of the eggs of the Cotton Flea Hopper, laid on or before September 1, are able to survive the high temperatures of that month, and remain dormant on the weeds until spring, the number of eggs passing the winter in this way sometimes being remarkably high. The eggs hatch in maximum numbers on April 6. Destruction of the weed food-plants in early autumn is essential if infestation in the following spring is to be prevented. In the heavy spring infestation of 1926, many dusts and sprays were tested; sulphurs again proved superior to all combinations not containing sulphur. A dust containing sulphur, naphthalene, and lime, and another containing sulphur and tobacco were especially promising.

580. CONTROL AND SPRING EMERGENCE OF THE COTTON FLEA HOPPER. By H. J. Reinhard. (*Bull. No.* 356, *Texas Agr. Exp. Sta.*, 1927.) In field experiments on the control of the Cotton Flea Hopper, superfine dusting sulphur, flowers of sulphur, Niagara sulphur-naphthalene, 60: 20: 20 sulphur-tobacco dust-lime, and 60: 40 sulphur-tobacco dust, all proved effective against the pest, remaining effective six to seven days when applied at the rate of 20 lbs. an acre. Spring emergence lasts over two or three months, but chiefly occurs in April. Ploughing host plants of the hopper under during the winter, and careful spring cultivation, are recommended as control measures. No natural enemies have been found which give promise of aid in reducing infestation, and growers must resort to remedial measures in combating the pest.

581. THE COTTON FLEA HOPPER. By C. O. Eddy. (*Bull.* 235, 1927, *Clemson Agr. Coll., S. Carolina.*) In South Carolina in 1926, early injury to cotton seedlings by the Cotton Flea Hopper resulted in stunting or retarding of growth, shortening of internodes, blasting of the buds, developing of an excessive number of branches very near together, and the forming of irregularly shaped leaves with marginal erosions and some holes. The nature of the injury indicated that it occurred in the buds, and observations showed its presence on unfolding leaves and other developing structures. The injury to older cotton was manifested in the shedding of large numbers of squares, abnormal growth of the plant often resulting in an excessive growth of the main stem and a suppression of the fruiting branches; this resulted in the loss of much of the early crop, and varying amounts of the middle crop. Plants known to be important alternate hosts are one species of croton, *Croton glandulosus*, L., and two species of evening primrose, *Œnothera biennis*, L., and *Œnothera laciniata*, Hill. Control measures suggested are clean culture and keeping terraces weed-free, and dusting with superfine dusting sulphur or commercial flour sulphur at the rate of 10 to 15 lbs. per acre.

582. A JASSID-RESISTING COTTON. (Abstr. from *East Afr.*, vol. iii., **149**, 1927, p. 1401.) Mr. Percy D. Krolik, a director of Cotton Plantations, Ltd., stated at the Second Ordinary Annual Meeting of the Company that, while in Portuguese East Africa recently, he learned that after four years' work, the Empire Cotton Growing Corporation had been able to evolve a type of cotton plant which was not only resistant to jassid, but would also command a substantial premium on American cotton. He considered that they were extremely fortunate in the assistance which they received from the Empire Cotton Growing Corporation and their specialists.

583. Observations on the Life History of Helopeltis on Cotton in Southern Nigeria. By O. B. Lean. (*Bull. Ent. Res.*, xvi., 1926, **4.** Abstr. from *Exp. Sta. Rec.*, lvi., **4,** 1927, p. 360.) The life history, habits, and control of the capsids *H. bergrothi*, Reut., and *H. sanguineus*, Popp., are considered.

584. Observations on Bucculatrix gossypiella, a New and Important Cotton Pest. By A. W. Morrill. (Abstr. from *J. of Econ. Ent.*, Geneva, N.Y., vol. xx., **3,** 1927, p. 536.) A species of cotton-infesting Bucculatrix (Family Lyonetiidæ), described as *B. gossypiella,* Morrill, infests wild and cultivated cottons in the States of Sonora and Sinaloa, Mexico. The adults closely resemble another cotton-infesting species, *B. thurberiella,* Busck, but can be separated by the genitalia in both sexes, while the egg and larval stages of the two species are strikingly different. The larvæ of *B. gossypiella* have the peculiar habit of boring in woody or hard tissues of the plant, such as stalks, branches, carpels of green bolls, leaf petioles, and larger leaf veins, as well as in the leaf blades and bracts, with decided preference for the harder parts. Characteristic reddish spots are produced by the work of the larva in the plant tissues. Damage appears to be confined to the staining of the lint, and to producing deformed and imperfectly opened bolls, usually amounting to between 10 and 30 per cent. of the crop. Observations to date indicate that early planting favours maximum damage, and late planting favours minimum damage, but local concerted action as to delayed planting and clearing of old cotton fields may be necessary where large acreages are involved.

585. New Injurious Curculionidæ (Col.). By G. A. K. Marshall. (*Bull. Ent. Res.*, xvii., **3,** 1927. Abstr. from *Rev. Appl. Ent.*, xv., Ser. A., **3,** 1927, p. 237.) The following new weevils injurious to cotton are described: *Protostrophus gulo, P. crinitus, P. vastator,* all from South Africa; *P. compactus* and *P. cognatus, Ellimenistes horridus,* and *Goniorrhinus hardenbergi,* on cotton in Portuguese East Africa; *Iphisomus ignavus,* on seedling cotton in Transvaal and Portuguese East Africa; *Chalcodermus bondari,* on cotton in Brazil.

586. The Influence of Temperature on the Maturation and General Health of Locusta Migratoria, L. By V. P. Pospelov. (*Bull. Ent. Res.*, xvi., **4,** 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **4,** 1927, p. 360.) A contribution from the State Institute of Experimental Agronomy, Leningrad.

587. Influence of Form and Proportion of Lime used, and of Method of Mixing on the Resulting Bordeaux Mixture. By E. B. Holland. (Abstr. from *J. of Agr. Res.*, xxxiv., **7,** 1927, p. 677.) *Summary.*—Four forms of lime (limewater, chemically precipitated lime, milk of lime, and commercial hydrated lime) were employed in preparing Bordeaux and allied mixtures. The activity varies directly as the degree of dispersion and decreases in the order named.

The best ratios of active lime in the several forms to copper sulphate, as judged by suspension, are as follows:

Limewater	0·538 gm.—0·109 gm.—100 c.c.
Precipitated lime	4 pounds—1·50 pounds—50 gallons.
Milk of lime	4 pounds—2·00 or 2·25 pounds—50 gallons.
Hydrated lime	4 pounds—2·00 pounds—50 gallons.

The best method of mixing, similarly judged, is by pouring dilute copper sulphate into concentrated lime or the two simultaneously into a third receptacle.

Some of the better grades of hydrated lime are promising substitutes for milk of lime, but require soaking before being used.

588. Report on the Occurrence of Angular Leaf-Spot of Cotton (*Bacterium Malvacearum,* E.F.S.) in Uganda. By J. D. Snowden. (*Uganda Dpt. of Agr.*, *Circular* No. 17, 1926. Abstr. from *Rev. Appl. Mycol.*, vi., Pt. 6, 1927, p. 354.)

The author claims to have isolated in 1926, from young cotton seedlings raised from seed from a local ginnery, and showing typical angular leaf spot lesions, a pale yellow bacterium, which entirely agreed in its cultural characters with *Bacterium malvacearum*. The pathogenicity of the organism to cotton was established by the inoculation of cotton bolls by pricking, which resulted in the production of spots surrounded by a water-soaked area, and of cotton seedlings by spraying, which gave from 61 to 86 per cent. positive results with typical stomatal infection; the organism was subsequently re-isolated. All the author's observations tended to confirm the view that the disease is carried on the seed; once it is introduced into a cotton plot it is readily spread by rain, as was clearly demonstrated in the experimental plots. There was no evidence that it is transmitted by insects to any great distance, but it seems probable that it is introduced into the bolls by their agency when the bracts are already infected. Following the discovery of the disease, a careful survey was made in Uganda which showed that it occurs without doubt throughout the country, though careful search had previously failed to reveal any trace of the disease.

Besides the usual method of seed disinfection with sulphuric acid, drying the seed with artificial heat, or by exposing it to sunshine for suitable periods, is also suggested, as preliminary experiments showed that the organism is killed when kept for two hours at a temperature of 52° to 55° C., or by a short exposure to bright sunlight. Some individual plants in the experimental plots also showed resistance to the disease, and this would suggest the possibility of breeding resistant varieties.

589. ASPERGILLUS NIGER. GROWTH. By A. Rippel and H. Bortels. (*Biochem. Z.*, 1927, 184. Abstr. from *Summ. of Curr. Lit.*, vii., **12**, 1927, A. 23.) Some preliminary experiments are described which indicate that *A. niger* spores germinate very slowly, and the mycelial growth is restrained if the atmosphere above the culture is freed from carbon dioxide.

590. ASPERGILLUS NIGER. ACID FORMATION. By H. Amelung. (*Z. Physiol. Chem.*, 1927, **166**. Abstr. from *Summ. of Curr. Lit.*, vii., **12**, 1927, A. 23.) Full details are given of culture experiments with two forms of *A. niger* on simple carbohydrates, using whole colonies for inoculation instead of spores. They produced citric acid from compounds with 3, 5, and 6 carbon atoms, gluconic acid from glucose, sucrose, and maltose only, but no acid at all from compounds with 4 and 7 carbon atoms. It was also found that with one of the moulds gluconic acid soon disappeared, followed by citric acid, and that the only acid left in old cultures was oxalic. The optimum temperature for acid formation was 34° to 36°, and the presence of salts had no influence on the amount of acid produced.

591. ASPERGILLUS NIGER. GROWTH STIMULATION. By A. Niethammer. (*Biochem. Z.*, **184**, 1927. Abstr. from *Summ. of Curr. Lit.*, vii., **12**, 1927, A. 23.) The stimulating effect of small doses of Uspulun, chromic sulphate, silver nitrate, lead nitrate, formaldehyde, salicylic acid, and thymol on the growth of *A. niger* is described. The literature on the subject is reviewed.

592. COTTON CLOTH: MILDEWING. By P. Bean. (*Text. Merc.*, **75**, 1926. Abstr. from *J. of Text. Inst.*, xviii., **5**, 1927, A. 175.) The author considers that the increase in complaints during the last three years of mildew in pure sized cotton cloth shipped to India is due to an increase in the amount of pressure put on the bales by the packers in order to reduce shipping charges. Six main causes of mildew in pure sized cotton cloth are enumerated.

593. COTTON CLOTH: MILDEWING. By G. Smith. (*Text. Merc.*, **75**, 1926. Abstr. from *J. of Text. Inst.*, xviii., **5**, 1927, A. 175.) In a reply to Bean (see

preceding Abstract), the author discounts the statements regarding the cause of mildew in pure sized cotton cloth, and emphasizes the gravity of the mildew problem.

594. Notes on Some Physiological Conditions affecting the Parasitism of Rhizoctonia solani, Kuhn. By M. Park. (*Year-Book Dpt. of Agr., Ceylon*, 1927. Abstr. from *Rev. Appl. Mycol.*, vi., **5**, 1927, p. 312.) The experiments recorded in this paper were carried out to ascertain the effect of soil moisture and humidity of the air on the disease caused by *Rhizoctonia solani*, which occurs on various plants in Ceylon. Cotton seeds were germinated in soils of varying water content infected with *R. solani*, and held in an atmosphere of 75 per cent. average humidity. The resulting seedlings showed 80 per cent. infection, while the controls remained healthy. When the atmospheric humidity was 52·2 per cent., only seedlings in the wettest soil were diseased. Increasing the humidity of the air by covering the plants with beakers resulted in infection and death of the covered seedlings. In a further series of experiments, it was found that in atmospheres of 100, 84·7, 54·6, 48·8, and 41·1 per cent. humidity, the percentages of affected plants were 100, 94·8, 84·4, 50, and 28·4 respectively. The extent of the attack on each seedling also showed a gradation through the series, until, in the driest atmosphere, only a small discoloured area at soil level was visible. All the controls remained healthy. These results are considered to indicate that the humidity of the air immediately above the soil plays an important part in governing the parasitism of *R. solani*.

Some recommendations for the control of this disease, based on the above experiments, are given. Nurseries should not be established in damp situations; shade in the nurseries should be reduced to a minimum; the soil drainage should be effective; and the spacing of plants should be wide. No such measures, however, can be successful in controlling the disease when the soil is infected.

595. Spermophthora gossypii. Cytology. By A. Guilliermond. (*Compt. rend.*, **184**, 1927. Abstr. from *Summ. of Curr. Lit.*, vol. vii., **12**, 1927, A. 24.) A cytological study of the stigmatomycosis fungus, *Spermophthora gossypii*, is described.

596. Stigmatomycosis Fungi. Description. By S. F. Ashby and W. Nowell. (*Ann. Bot.*, **40**, 1926. Abstr. from *Summ. of Curr. Lit.*, vol. vii., **12**, 1927, A. 24.) The characters of *Spermophthora gossypii*, *Eremothecium cymbalariæ*, *Nematospora gossypii*, and *N. coryli* are discussed. *S. gossypii* was heavily predominant in the bolls of Sea Island cotton in St. Vincent in 1916-17, at times during the crop season when the plants were heavily infested with cotton stainers. It has also been recorded from cotton bolls in Jamaica, Nevis, Montserrat, the Grenadines, and Trinidad. *E. cymbalariæ* was found in cotton bolls in St. Vincent, Montserrat, Tortola (Virgin Islands), and Nevis, occurring in 89 to 95 per cent. of the infections in parcels of bolls received from the two last-mentioned islands early in 1918. *N. gossypii* occurred in cotton bolls in Montserrat, Antigua, Nevis, St. Vincent, the Grenadines, and Trinidad, occurring in 90 to 100 per cent. of infections in parcels of bolls from Montserrat collected in 1917 and 1918, and also occurred in cotton bolls from Nyasaland. *N. coryli* is by far the most generally distributed agent of stigmatomycosis in the West Indies. Its occurrence on cotton is usually associated with infestation by the green bug, *Nezara viridula*, or other bugs with a wider range of host plants than is frequented by cotton stainers.

597. Cotton Wilt Disease. (*Arkansas Sta. Bull.* 215, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **4**, 1927, p. 347.) In continuation of work previously reported on the development of wilt-resistant strains of cotton (Arkansas Bull. No. 203),

tests were made of a large number of strains and varieties of cotton grown in heavily infested soil, but very little wilt resulted. In seeking for a possible explanation of the lack of wilting, physiological studies were made of the parasite, and it was found that in cultures in the absence of organic nitrogen the fungus was able to produce at least two substances which were toxic to cotton, while in the presence of organic nitrogen, either no toxic substances were produced or they were in such dilution as to exert no injurious effect. The breeding work of the station is said to have shown marked differences in types of cotton in reference to their susceptibility to wilt. In connection with the plant-breeding experiments, delinting the seed with sulphuric acid proved a good means of controlling angular leaf spot. Using soil temperature control tanks, it was found that cotton wilt develops to only a slight extent in temperatures above 35° C., and it is believed that it will not develop to any appreciable extent below 25°. The optimum for growth is considered probably about 27 or 28°.

598. The Wilt Disease of Cotton. By T. E. Fahmy. (Cong. of Int. Fed. of Master Cotton Spinners' Manufrs. Asscn., Egypt, 1927. Abstr. from *Rev. App. Mycol.*, vi., **5**, 1927, p. 290.) The author describes the symptoms of the wilt disease (*Fusarium vasinfectum*) of cotton as it occurs in the cotton-growing areas of Egypt, chiefly in the Delta region. The plants are infected in the seedling stage through the root system, and generally die owing to a complete rotting of the roots. Different varieties of cotton show a marked variation in susceptibility to the disease. Sakel is extremely susceptible, while Ashmouni and Zagora are immune. Breeding experiments have, however, resulted in the isolation of four strains of Sakel which are of good quality, and which so far appear to be quite immune from wilt.

[And *cf.* Nos. 542, 550.]

BREEDING, GENERAL BOTANY, ETC.

599. The Importance of Cotton Breeding to the Spinner. By Dr. S. C. Harland. (*Text. Rec.*, vol. xlv., **531**, 1927, p. 87.)

600. Growth and Development of Cotton Plants at Greenville, Texas. By H. C. McNamara *et al.* (*U.S. Dpt. of Agr., Dpt. Circ.* 401, 1927. Abstr. from *Exp. Sta. Rec.*, **56**, 6, 1927, p. 529.) The growth and behaviour of the cotton plant was observed under various cultural methods as affected by environmental conditions at Greenville, Texas. The effect of different planting dates at weekly and longer intervals, and spacing 12-inch and unthinned upon the normal rate and sequence of production, and the growth and development of fruiting parts was studied with Lone Star cotton. Comparative studies on growth and development were also made with Kasch, Mebane Latest Improved, Rowden, Truitt, Lone Star, Acala, and Kekchi.

Flowers appeared in ascending series along the main axis of the plant, about three times as fast as in a horizontal series along the fruiting branches. The intervals between the appearance of flowers on the first nodes of successive fruiting branches averaged 2·4 days, and between the appearance of successive flowers on the fruiting branches of the same plants, 6·2 days. The germination and early growth of seedlings were more rapid in the late plantings. The period from planting to appearance of the first square ranged from fifty-eight days on an April 2 planting, to nineteen days for plantings made July 24 and August 15. The interval between appearance of successive fruiting branches was little affected by the planting date. For 1923 the means ranged from 2·28 to 2·93 days. In 1924 there was a slight tendency for the intervals between the appearance of successive fruiting branches to be longer on closer spacings. The intervals between the appearance of successive squares on fruiting branches were very

irregular without significant differences between the different planting dates. The intervals between the appearance of successive squares on fruiting branches were longer in unthinned rows than in 12-inch spacings of each planting date.

The rate of square production appeared to be directly related to the vegetative vigour of the plants, and not necessarily affected by the advance of the season. Long intervals between the appearance of squares may occur at any time during adverse weather conditions, or when the plants are reaching maturity, or bearing a heavy crop of bolls. The square period, the time from the appearance of a square until it flowers, tended to shorten on later plantings, and was longer on unthinned cotton than on 12-inch spacing. The lengthening of the square period on the outer nodes of the branches appeared to be definitely related to the position on the plant or the slowing up of plant growth during the late season.

The maturation period of bolls was little affected by the planting date, lengthened with advance of season, and was also somewhat longer in unthinned rows, especially where the stand was very thick, than in 12-inch spacing. The period from planting to maturity was much longer on the earlier plantings, but most of this was in the seedling stage before the appearance of the first square.

601. GROWTH, BUD-SHEDDING, AND FLOWER PRODUCTION IN EGYPTIAN COTTON. By M. A. Bailey and T. Trought. (*Tech. and Sci. Serv. Bull.* 65, Min. of Agr., Egypt.) *Section I.—The Relation between Growth and Flower Production.* As shown by the authors previously, rate of differentiation must be approximately constant in the single plant in Egypt, in order to give the observed constancy of flowering intervals. Elongation probably depends primarily on the availability of water in the plant as affected by temperature and transpiration. The curves show that rate of elongation increases to a maximum and then falls. A similar change in rate of differentiation during the period of flower production does not occur.

The relation of elongation to increase in mass is discussed, and it is shown that rate of elongation is not a satisfactory index to rate of increase in mass in cotton.

High temperatures may have a temporarily depressant effect on rate of elongation, due either to thermotoxy, or possibly to the fact that excessive transpiration is induced.

The significance of the fit between daily fluctuations in rate of increase in height and daily fluctuations in rate of flowering as claimed by Balls depended on the fact that the shift of the elongation curve for coincidence with the flowering curve represented a period (viz., four weeks) which he considered equal to the period of development of the flower.

The authors have shown previously that this development period is very considerably longer (viz., forty-two days) than that postulated by Balls. They have, however, been unable to find a fixed relation between elongation and flowering at a forty-two day interval, or any other interval. This accords with the authors' expectations, and can be deduced from the observed constancy of flowering intervals due to a presumed constant rate of differentiation, as mentioned above.

The daily fluctuations in rate of flowering, therefore, do not depend on fluctuations in rate of differentiation or rate of elongation.

Section II.—The Relation between Bud-Shedding and Flower Production.—The authors are of opinion that the following facts are very clearly established as the result of their experiments:

1. That bud-shedding often occurs in such quantity that it is bound to have an overwhelming effect on the subsequent production of flowers.

2. That the great majority of buds fall off at a very early stage, when the bud is only about two millimetres or less in width measured across the epicalyx.

3. That bud-shedding does not occur in a haphazard manner. Conditions which tend to produce bud-shedding in one lot of plants also tend to produce it in a neighbouring lot.

4. That bud-shedding does not occur at a uniform rate throughout the season. The rate of bud-shedding shows minor fluctuations from day to day, and major fluctuations over longer periods.

5. That conditions which induce shedding of the smallest buds also induce shedding of other sizes of buds.

602. A MUTANT IN COTTON. By G. L. Kottur. (Extract from *Nature*, vol. cxix., **3003**, 1927, p. 747.) "On the Government Farm at Dharwar, Bombay Presidency, I have for several years had under observation pure lines of cotton of several species and varieties. One of these was *Wagale*, a Burmese variety of *Gossypium neglectum*, Tod. From 1919, this variety has been self-fertilized, and only the self-fertilized seed used for sowing in each generation, of which there has been one per annum. Like all the Indian cottons, this variety has normally had simple and stellate hairs on stem, petiole, and leaf. The variety bred true for this character of hairiness until 1925, in which season there appeared one plant which was entirely glabrous.

The normal plant has a ginning percentage of about 30, but the hairless plant had no lint at all, although its seeds showed the shorter "fuzz." The petal length was also shorter than normal, averaging 17 mm., as against the normal 35 mm. This plant was self-fertilized, and seeds were produced. In the season of 1926-27 these seeds were sown, giving eighty plants, all showing absolute hairlessness, lack of lint, and short petals. This new type appears to be a genuine mutant. Its behaviour in further generations and in crosses is being studied."

603. COTTON LEAF STORAGE CARBOHYDRATES. COMPOSITION. By G. H. Jones. (*Ann. Bot.*, **41**, 1927. Abstr. from *Summ. of Curr. Lit.*, vol. vii., **12**, 1927, A. 23.) When cotton leaves are tested for starch in the usual way, none is found, and it might be presumed that the oil which is present in all green parts of the plant is the temporary storage product of photosynthesis, but the oil does not disappear from leaves kept in the dark, nor is there any appreciable diurnal variation in quantity. After clearing the leaf with caustic potash, however, it is possible to obtain excellent starch prints.

604. CHEMOTROPISM IN THE COTTON PLANT. By Professor F. Hardy. (Abstr. from *Trop. Agriculture*, vol. iv., **6**, 1927, p. 102.) It has been known for some time that the moist layer on the under surface of the leaves, and on the buds and young shoots of the cotton plant, is markedly alkaline in reaction (pH 8·5 or thereabouts), whereas the tissue fluid, as is the case with the great majority of plants, is acidic (pH 5·2 to 5·5). This implies that some sort of alkaline substance is exuded by the plant and dissolves in the dew. (See C. M. Smith, *J. Agr. Res.*, 1923, **26**, p. 192; J. E. Mills, *Science*, September 19, 1924, p. 268, and Harris, Hoffman, and Johnson, *ibid.*, January 16, 1925, p. 65.) These observations have suggested that a soluble volatile base, probably belonging to the alkyl amines, is produced and liberated by the cotton plant, and, further, that this substance may be, at least in part, responsible for the specific attraction which the cotton plant exerts towards certain of its insect pests, in particular the cotton boll weevil, which annually demands high toll in the cotton fields of America.

The importance of these facts and suggestions do not need stressing. Obviously, if the exact identity of the chemotropic substance of the cotton plant could be established, the substance may be synthesized or otherwise obtained in sufficient quantity to permit its use as a bait for trapping those insect pests of the cotton plant that react specifically to its influence. Hence great economic significance attaches itself to any attempts to identify the odorous volatile component of the cotton plant.

The history of the subject is then discussed, more especially the recent experiments of the U.S. Dept. of Agriculture. Ammonia and trimethylamine were found in some quantity in addition to various other substances. Further experiments are in progress.

605. COTTON HAIR. STRUCTURE. By F. P. Slater. (*J. Soc. Dyers*, **43**, 1927. Abstr. from *Summ. of Curr. Lit.*, vii., **13**, 1927, A. 25.) A report of a lecture giving a structural picture, based on the work of Balls and Hancock, of the cotton hair. The subsequent discussion is appended.

606. OCCURRENCE OF BRANCHED HAIRS IN COTTON AND UPON GOSSYPIUM STOCKSII. By W. Youngman and S. S. Pande. (Abstr. from *Nature*, vol. cxix., No. 3003, 1927, p. 745.) A brief note, with illustrations, dealing with the occurrence of branched hairs on *Thespesia populnea* and *Gossypium Stocksii.*

607. INHERITANCE OF RATE OF SHEDDING IN A COTTON HYBRID. By T. H. Kearney. (Abstr. from *J. of Agr. Res., U.S.*, vol. xxxiv., No. 10, 1927, p. 921.) Study of the second generation of the interspecific cotton hybrid Pima Egyptian × Acala Upland suggested that the shedding of flower buds and young bolls is determined partly by genetic factors. Conclusive evidence that such is the case was afforded by third generation progenies of F_2 plants, which had shown, respectively, a high, intermediate, and low rate of shedding. The coefficient of parent-offspring correlation (F_2 with F_3) was $0{\cdot}715 \pm 0{\cdot}085$ for the total shedding percentage (buds and bolls shed as a percentage of total buds), and $0{\cdot}621 \pm 0{\cdot}107$ for the boll-shedding percentage (bolls shed as a percentage of total flowers).

Further evidence that genetic factors are involved is given by the positive correlation between rate of bud-shedding and rate of boll-shedding in both F_2 and F_3 of the hybrid. This fact proves that the inherited tendency to a high or a low rate of shedding expresses itself in abscission both before and after anthesis.

There was a tendency to greater sterility in F_3 than in F_2, as was noted also in an earlier investigation of an Upland-Egyptian cotton hybrid, but the data at hand do not suggest a satisfactory genetic explanation of this difference between the two generations.

608. VARIATION IN CERTAIN LINT CHARACTERS IN A COTTON PLANT AND ITS PROGENY. By E. P. Humbert and J. S. Mogford. (*Bull.* 349, *Texas Agr. Exp. Sta.*, 1927.) Bolls taken from different parts of the parent plant showed variation in the length of lint. These variations were also found to occur in the same boll, in the same lock, and on seed side by side in the same lock. The position of the bolls on the parent plant, and also the date on which these bolls opened, apparently had no consistent influence on the length of lint in the parent plant or in the progeny. This indicates that the plant should be considered as a unit in making selections for breeding purposes.

Some bolls of the parent plant which were uniform with respect to length of lint produced progeny which were variable in the length of lint. Other bolls of the parent plant which were variable in the length of lint produced progeny which were less variable. These variations are probably environmental in their origin, and would not be transmitted to another generation.

The percentage of lint in the progeny does not appear to have been as variable as the length of lint, when comparison is made between rows as a unit. Individual plants in some of these progeny rows, however, exhibited some variation in the percentage of lint. The mean percentage of lint of each of the progeny rows showed very little variation.

There appears to be no correlation in the length of lint between individual seeds of the parent and their progeny. Some of the plants in the progeny re-

sembled the parent with respect to length of lint; while other plants in the progeny produced some lint which was longer and some which was shorter than the lint on the parent plant. The mean length of lint of the progeny, however, very closely approached the mean length of lint of the parent plant.

[And *cf.* No. 490.]

CO-OPERATION.

609. Enlightened Co-operation in U.S.A. Cotton Industry. By H. B. Killough. (*Int. Cot. Bull.*, vol. v., **4**, No. 20, 1927, p. 633.)

LEGISLATION.

610. Tanganyika Territory. *The Cotton (Fees) Rules*, dated April 12, 1927, state the fees payable for the year ending March 31, 1928, in respect of Ginnery, Cotton Buyer's or Cotton Market Buyer's and Baling licences.

611. Australia. *The Cotton Bounty (Seed Cotton) Regulations* of February 23, 1927, provide that cotton is to be graded into higher grades (down to Low Middling), receiving a bounty of 1½d. per lb., and lower grades (down to Good Ordinary), receiving a bounty of ¾d. per lb.

612. Uganda. *Cotton Ordinance No.* 11, dated December 22, 1926. An Ordinance to secure and maintain the production of the highest quality of cotton, and in general to regulate and control the cotton industry.

613. United States. *Regulations of the Secretary of Agriculture under the United States Cotton Futures Act.* (*U.S. Dpt. of Agr. Serv. and Reg. Announcements*, No. 105.) A detailed description of the regulations. Twenty grades (nine white) are deliverable upon contract, besides ten of low-grade cotton.

614. French Colonies. (Abstr. from the *Journ. Officiel* of July 18, 1927, received from the Dept. of Overseas Trade.) The law of March 31, 1927, authorized the imposition of a tax of 1 franc per 100 kilos upon all importations of cotton, the proceeds of the tax to serve for the development of cotton cultivation in the Colonies, and to be divided among the various enterprises and organizations interested.

CHEMISTRY AND PHYSICS IN THEIR APPLICATION TO COTTON PROBLEMS.

615. The Viscosity of Cuprammonium Solutions of Cotton Cellulose. By F. C. Hahn and H. Bradshaw. (*Indus. and Eng. Chem.*, xviii., No. 12, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **6**, 1927, p. 594.) In viscosity studies made with solutions derived from a representative series of different grades of linters, and from four distinct samples of long staple cotton, the figure for the linters' samples exceeded those for the long staple cotton. There also seemed to be a progressive rise in viscosity from low-grade second cut to high-grade mill run linters, and then a drop to first cut linters, and a further drop to long staple cotton.

616. Cotton: Fibre Length Percentage. (*Cotton U.S.*, **90**, 1926. Abstr. from *J. of Text. Inst.*, xviii., **6**, 1927, A. 211.) The use of a sorting machine (an illustration shows the Baer sorter) for sorting cotton by lots is advocated. In two lots of cotton bought as ⅞ inch to 1 inch staple, the percentage of fibre of ⅞ inch or over was (lot 1, 14 bales) 50·7 per cent., (lot 2, 12 bales) 44·2 per cent.

617. Cotton Linters Cellulose. Preparation. By F. Olsen. (*Chem. Abs.*, **21**, 1927. Abstr. in *J. of Text. Inst.*, xviii., **5**, 1927, A. 148.)

618. Cotton Yarn: Mercerization. By W. F. A. Ermen and S. H. Jenkins. (*J. Soc. Dyers and Cols.*, **43**, 1927. Abstr. in *J. of Text. Inst.*, xviii., **5**, 1927, A. 166.)

619. Absorption of Water by Cotton Mercerized with and without Tension. By A. R. Urquhart. (Abstr. in *J. of Text. Inst.*, xviii., **5**, 1927, A. 166.)

620. The Chemical Analysis of Cotton. The Effect of the Disruption of the Cotton Hair on the Extraction of Fat, Wax, and Resin. By R. G. Fargher and L. Higginbotham. (*Shirley Inst. Mems.*, vol. vi., June, 1927.)

621. Cold-Bleaching of Cotton. (*Text. Rec.*, xlv., **531**, 1927, p. 105.)

622. Improved Testing of Yarn Strength. (Extract from *Cotton*, June 18, 1927.) The United States Bureau of Standards has developed an improvement on the skein test for breaking yarns. By the old method, 120 yards of yarn are first wound on a reel 1½ yards in diameter. This skein, consisting of eighty strands, is then placed on drums in the testing machine and broken. Some modifications of this test have been suggested, notably the proposed method of the American Society for Testing Materials for testing rayon. This method requires that a segment of the skein be cut from it, the yarns made as nearly parallel as possible, and broken in the jaws of the testing machine in a manner similar to the strip test for cloth.

The new method developed at the Bureau is as follows:

The yarns are wound with controlled tension around an elongated **U**-shaped rod of sufficient diameter to permit the insertion of a transfer clamp between the two layers of yarns. Using the clamp, the yarns are inserted between the jaws of the testing machine, after which the clamp is removed.

The advantages of this method are that the yarn is tensioned equally, and this tension is preserved until the start of the test. Consistent results have been obtained, especially with stress-strain curves.

623. Yarns: Breaking Load Irregularity. By H. Rudolph. (*Melliand Textilber*, **7**, 1926. Abstr. in *J. of Text. Inst.*, xviii., **5**, 1927, A. 152.)

624. A Photographic Method of Investigating the Colour of Light Sources, and the Reflecting Power of Coloured Fabric and Other Surfaces. By P. W. Cunliffe andd F. D. Farrow. (*Shirley Inst. Mems.*, vol. vi., July, 1927.)

625. Combed Yarns: Identification. By W. Bauer. (*Melliand Textilber*, **7**, 1926. Abstr. in *J. of Text. Inst.*, xviii., **5**, 1927, A. 152.)

626. Manufacturing Tests of Cotton of the White Grades of the Universal Standards for American Cotton. By H. H. Willis. (*Bull.* 1488, *U.S. Dpt. Agr.*, Washington, D.C., 1927.) The strength of the yarn did not always follow the grade of the cotton, but there was a tendency for the higher grades to produce stronger yarns.

627. Cottonseed Meal and Hulls *v.* Mixed Soybean and Grass Hay for Wintering Ewes. (*S. Carolina Sta. Rpt.*, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., **6**, 1927, p. 561.) Forty ewes were divided into two lots and fed for seventy days. One lot received cottonseed meal and hulls, and the other mixed soybean and grass hay. After twenty-eight days, the ewes on hay had failed to gain, so cottonseed meal was added to the ration. The ewes on cottonseed meal and hulls gained 18 lbs. per head at a cost of $1·54, and those on hay gained 13 lbs. at a cost of $2·09. A record of the weight of the lambs at birth showed that those from the cottonseed meal and hull ewes weighed 7·77 lbs., and those from ewes fed on hay averaged 7·95 lbs.

628. Cottonseed Meal *v.* Ground Corn as a Fattening Feed. By C. W. McCampbell *et al.* (*Kansas Sta. Circ.* 128, 1926. Abstr. from *Exp. Sta. Rec.*, lvi., 4, 1927, p. 364.) Two lots of yearling steers, averaging approximately 550 lbs. in weight, were fed on a ration of alfalfa hay and silage plus cottonseed meal in one lot, while the other lot received 1 lb. of cottonseed meal per head daily, and sufficient corn to make the combined amounts of concentrates in the two lots equal. For the 140-day feeding period, the former consumed 11·04 lb. of cottonseed meal per head daily, and the latter 10·04 lb. of corn and 1 lb. of cottonseed meal. The average daily gains of the respective lots were 2·39 and 2·43 lbs., but the former lot was a little better finished. Ground corn fed in this way proved to be worth approximately 95 per cent. as much as cottonseed meal, though its ordinary market price is relatively much below that proportion.

629. Cottonseed Oil. Composition. By G. S. Jamieson and W. F. Baughman. (*Oil and Fat Ind.*, 4, 1927. Abstr. from *Summ. of Curr. Lit.*, vii., 10, 1927, B. 46.) The following are the compositions of a sample of Upland type (short fibre) cottonseed oil, and of a sample of Sea Island type (long fibre) oil:

Glycerides of	*Upland Type Cottonseed Oil.*	*Sea Island Type Cottonseed Oil.*
Oleic acid	30·5	35·2
Linolic acid	44·8	41·7
Myristic acid	0·5	0·3
Palmitic ,, ...	21·9	20·0
Stearic ,, ...	1·9	2·0
Arachidic ,, ...	0·1	0·6
Unsaponifiable matter	0·9	—

[And *cf.* Nos. 513, 521, 522, 528, 551, 552, 554, 556, 557, 558, 559, 560, 600.]

MISCELLANEOUS.

630. We have received a copy of the special issue of the *Journal of the Textile Institute*, being the Official Record of the Annual Conference of the Textile Institute held at Bolton in June, 1927, in association with the Samuel Crompton Centenary Celebrations. The full text of the papers contributed to the Conference are given, and many excellent illustrations are included.

631. The Application of Producer Gas to Motor Transport. (Abstr. from *Text. Rec.*, xlv., 532, 1927, p. 73.) An interesting general account of the use of producer gas in motor driving, the usual fuel being charcoal. Too much emphasis cannot be laid on the established fact that given the proper conditions of engine layout, producer gas will give as effective service as petrol. Engine life will be longer, and, more important still, running costs in many places will be fractional to the cost of using motor spirit.

632. Coton et Syndicats. By M. E. de Wildeman. (Abstr. from *Agr. et Elevage au Congo Belge*, No. 10, 1927, p. 112.) A review of the paper by Mourad Kamel Bey given at the recent Congress at Cairo.

633. New Cotton Areas for Old. By Dr. A. B. Cox. (Abstr. from *Int. Cot. Bull.*, v., 4, No. 20, 1927, p. 554.) Deals, among other matters, with the history of cotton, the world's demand for cotton, the world's acreage and yield per acre, the amount and sources of acreage increases, the countries where the acreage may be reduced, and the probable amounts of reduction.

634. Considerable Cotton Takings. (Abstr. from *Text. Rec.*, xlv., **532**, 1927, p. 92.) According to Messrs. Reiss Bros., Liverpool, the quantity of cotton taken by spinners to the end of June last amounts to some 17,750,000 bales, of which exports are 11,000,000 bales. These figures are remarkable, and it is essential that a large crop for next year should be forthcoming. The world is absorbing more cotton every year, and there is more need than ever that we should increase our production within the Empire. Continental Europe and Japan are using more and more American cotton. In 1911 we took 44 per cent. of the U.S. exports, and America 33 per cent., while to-day we have only taken 25 per cent., and America has consumed 50 per cent. The figures are significant.

635. The Port of Liverpool. (Abstr. from *Man. Guard. Coml.*, July 14, 1927.) A good account of Liverpool and its trade. An interesting article on "The Cotton Market," by B. H. Hird, is included on pp. 21-22.

PERSONAL NOTES

APPOINTMENTS.

Sudan.

Mr. F. E. Kenchington, a former holder of a Senior Studentship, has been appointed by the Corporation as Assistant to Mr. Bailey, at Shambat, Khartoum.

West Indies.

Imperial College of Tropical Agriculture, Trinidad.

Mr. G. Evans, C.I.E., has been appointed Principal of the College, in succession to Dr. H. Martin Leake, who has resigned.

Mr. R. Cecil Wood, Cotton Specialist in Swaziland, has resigned his appointment under the Corporation to take up the post of Professor of Agriculture at the College.

STUDENTSHIPS.

The following have been elected to Studentships under the Corporation for the year 1927-28. They will hold their Studentships at the place named in the second column:

Seniors.

Name.	*Studentship tenable at—*
W. Allan	Trinidad.
A. G. Bebbington	,,
H. R. Hosking	,,
H. Hutchinson	,,
A. H. Lewis	,,
R. M. Maynard	,,

Juniors.

C. W. L. Fishlock	Cambridge.
R. L. Knight	,,
C. W. Lynn	,,
A. Pickles	Imperial College, London.
A. N. Prentice	Cambridge.
R. Turner	,,

In addition to the above, a special grant has been made to Mr. R. I. Nel, the holder of a scholarship from the University of Stellenbosch, South Africa. Mr. Nel will continue research in entomology at the Imperial College of Science and Technology.

The following holders of Senior Studentships last year have received appointments as under:

South Africa.

Mr. P. A. Bowmaker has been appointed by the Corporation as Assistant to Mr. Parsons, to work at the Experimental Station at Candover, Natal.

Mr. O. V. S. Heath and Mr. L. H. A. Stone have been appointed by the Corporation as Assistants to Mr. Parnell at the Plant Breeding Station, Barberton, Transvaal.

Mr. J. L. Moerdyk and Mr. V. F. O. Olivier have returned to South Africa to take up posts under the Union Department of Agriculture.

Swaziland.

Mr. D. Macdonald has been appointed by the Corporation to take over the work initiated at Bremersdorp Experimental Station by Mr. R. C. Wood, who has accepted the post in Trinidad mentioned above.

OFFICERS ON LEAVE.

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes "home" on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would call at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite to the offices of the Crown Agents for the Colonies.

At the date of writing, the following officers are on leave in England from cotton-growing countries:

Fiji	Mr. H. C. Taylor.
Gold Coast	Mr. A. W. Paterson.
Iraq	Mr. F. K. Jackson.
Kenya Colony	Mr. V. A. Beckley.
Nigeria	Mr. A. G. Beattie.
,,	Mr. P. H. Lamb.
,,	Mr. E. B. Wilson.
Sierra Leone	Mr. P. J. Moss.
Tanganyika	Mr. A. H. Kirby.
Uganda	Mr. P. Chandler.
,,	Mr. G. L. R. Hancock.
,,	Mr. A. B. Killick.
West Indies	Prof. J. P. d'Albuquerque.
,, ,,	Mr. W. G. Freeman.
,, ,,	Mr. E. A. Walters.
,, ,,	Mr. F. H. S. Warneford.

The following officers of the Corporation's staff abroad are on leave in this country:

Mr. S. Milligan	South Africa.
Mr. M. A. Bailey	Sudan.
Mr. E. Ballard	Queensland.
Dr. E. J. Maskell	West Indies.
Mr. W. L. Miller	Nyasaland.
Mr. E. J. Salter	Northern Rhodesia.

THE EMPIRE COTTON GROWING REVIEW

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PRINTED IN GREAT BRITAIN BY
BILLING AND SONS, LTD., GUILDFORD AND ESHER

Date of issue.	Date of issue.	Date of issue.

MGIPC—S5—38 AR/54—7-7-54—7,000.